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ALASKA-YUKON CARIBOU

By

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UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF BIOLOGICAL SURVEY

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ALASKA-YUKON CARIBOU

By OLAUS J. MURIE, *Biologist, Division of Wildlife Research*

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THE CARIBOU IN RELATION TO MAN

The American people, becoming more aware of their heritage in the North, are visiting Alaska in increasing numbers—as sportsmen, as tourists, as prospective settlers. Important among the attractions to the wilderness portions of the Territory are the wandering caribou herds. Though from the standpoint of the hunter the caribou is a stupid animal and easily stalked, it is picturesque, interesting in its ways, and enveloped in mystery as it wanders over its subarctic ranges. Not only does the visiting sportsman find more pleasure in his excursions into these northern game lands because of the presence of the caribou herds, but great opportunities are also offered one who carries a camera.

In the early exploration of Alaska the caribou made existence possible in regions where it would have been hard to survive otherwise. Mining camps and prospectors have found the caribou a god-

send, in the food it furnishes for both man and his indispensable dog. The caribou herds have meant to Alaskans what the bison meant to the early explorers and settlers of the Western States. To this day some mining camps depend largely on the caribou herds for fresh meat. As an accompaniment to this necessity market hunters made a business of supplying meat in the early days. Formerly in interior Alaska, where the population was scattered and caribou held their own under such practices, the sale of meat was justifiable. Conditions have changed, however, and market hunting, or sale of game, is now looked upon with disfavor.

There have been occasions when outrageous practices were indulged in, with great waste of game, but on the whole the caribou herds have not been wrongly used to the same extent as were the bison herds, and Alaskans are still enjoying the benefits of abundant game. In earlier times the Indians depended on caribou for food and clothing, and the Eskimos, normally seeking a living from the sea, made excursions inland to obtain the fresh meat. In some sections, when the caribou failed to appear in their regular migrations the natives suffered hardships, as they do even today in some parts of the Territory.

Before the day of firearms it was necessary to use great ingenuity to bag big game. Traces of native handicraft still remain in many parts of Alaska, proof of the cleverness of the aboriginal hunter. At various points in the Kechumstuk region the Indians established look-outs for spying caribou, usually on the brow of a hill affording a good view of a wide stretch of country. In some cases a convenient tree was trimmed, a rough platform made on the limbs near the top, and the limbs cleared away so as not to obstruct the view (pl. 1, *A*). Look-out trees were found on Mosquito Fork and at the head of the west branch of Dennison Fork, and on a hill near the Kechumstuk corral (p. 3) an elaborate structure had been built of poles, with a platform near the top (pl. 1, *B*).

A favorite method of capturing caribou was by means of snare fences (pl. 2, *A*). A pole fence was constructed, sometimes extending for miles in the path of the migrating herds. At intervals a gap was made, in which was placed a rawhide noose. The caribou, seeking to pass the fence, would find the opening and as they attempted to go through would be caught in the snare.

A number of such fences were found by the author in 1921, the most perfect examples in the Kechumstuk country,¹ where caribou migrate regularly. One of these examined in the summer of 1921 near the head of Little Dennison Fork extended about a mile, following an old telegraph-line trail from Eagle to Mentasta Pass. Averaging between 4 and 5 feet in height, the sections were built of 4 or 5 rails fastened to posts by willow withes. Although broken down in places, the fence elsewhere was still in good condition, and in an opening at one point lay a caribou skeleton, the wire noose of the snare enclosing the cervical vertebrae. At another point a short wing fence had been built at right angles to the main line, the corner forming a gap for a snare.

¹The upper Tanana Indians called the snare fence "thak" or "tak" and the look-out tree "en-tak-ke" or "en-tak-go", the similarity of the words indicating that both are involved in the same pursuit.



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A, Spruce tree trimmed by Indians for a look-out in spying caribou. *B*, An Indian look-out at Kechumstuk (all poles are fastened by willow withes).

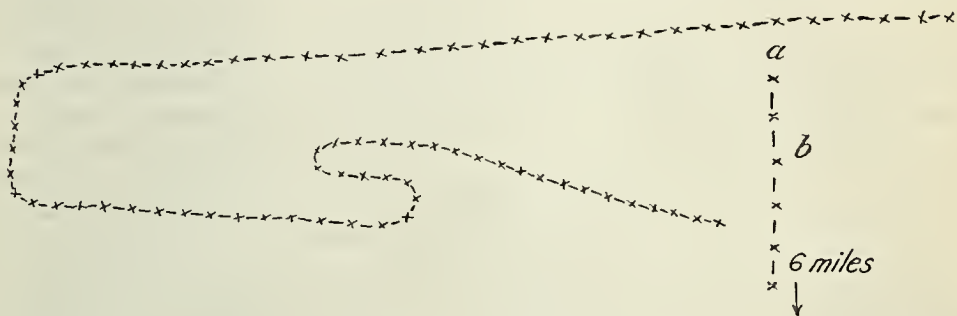


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A. Section of an old caribou snare fence held together by willow withes. B, Old caribou corral, partly broken down. C, One side of caribou corral at Kechumstuk (long wing fences guided the animals into the enclosure).

Near the Indian village known as Kechumstuk was a more elaborate structure (pl. 2, *B* and *C*). A line fence extended westward about 6 miles, according to a homesteader who lived nearby. At the east end the Indians had constructed a corral, the plan of which is shown in figure 1.² The whole structure, fastened entirely by willow withes, was well built, and the parts still standing were firm. The inner corral or pocket was more than 6 feet high and reinforced by vertical poles close together. A band of caribou, following the lead fence, would be led into the corral. Then the entrance was guarded by a number of Indians, while one on each side shot the caribou with bow and arrow. Sometimes a hunting knife was lashed to the end of a pole and the animals were speared through the fence.

According to an Indian at Tanana Crossing, who explained the use of the enclosure, this fence was used regularly "about 12 years ago", when he was a boy, but, as the Indian was at least 40 years old, his estimate of 12 years is not reliable. He stated that he was



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FIGURE 1.—Plan of caribou corral, parts of which are shown in plate 2, *B* and *C*. Animals following the 6-mile-long lead fence, *b*, were led into the corral at the entrance, *a*, 35 feet wide. The distance from the entrance to the other end of the corral was 510 feet.

too small to hunt, then, and that his father did the hunting. Probably 25 or 30 years (before 1921) would have been a fair estimate of the time since this fence had been used. The Indian informant, shown a diagram of the corral, gave little importance to the inside pocket, so carefully built, and declared that the animals were killed anywhere along the sides of the main corral. The care with which this inner enclosure had been reinforced indicated, however, that it must have served a definite purpose.

Residents on the North Fork of the Fortymile River told of a caribou snare fence extending from a point about a mile up this stream to within about a mile and a half of the mouth of O'Brien Creek, following the left limit of the Fortymile.

Snare fences were reported from several other localities. According to a native reindeer herder, Eskimos formerly built such fences in the lower Kuskokwim region; and a trader on the Yukon, formerly at Point Barrow, stated that he had seen Eskimos on the Arctic slope build guide fences of dirt piles or heaps of niggerheads leading to a lake. When the caribou, thus guided to the water, attempted to swim across, Eskimos lying in wait darted out in kayaks

² Drawings in this publication are by the writer, from sketches made in the field.

and speared the swimming animals. This account was corroborated by various Eskimos, who also told that in the Colville River basin large willows were used in constructing guide fences. P. G. Lowe (1899)³ reports seeing an old caribou snare fence near Boulder Creek, above Sanford River, in Copper River Valley.

In a few instances such primitive hunting methods persist. In the spring of 1921, several short snare fences, with snares made of abandoned telegraph wire, were noted near Tanana Crossing. These fences were flimsy structures, carelessly thrown together, but in the fall of 1920 five caribou had been caught, and in April 1920 a young bull moose had been snared. The abandoned telegraph wire along the route from Eagle to Valdez has also accidentally caused the death of a number of caribou. Several skulls were found with a mass of this wire entangled in the horns. On one occasion a large bull had become entangled and had fought until the wire wound up, mostly on one horn, snubbing him closely to a tree. That antler had finally broken off, and the animal had escaped.

Caribou are still snared by the Indians at the mouth of Old Crow River, in Yukon Territory. A missionary at that place showed samples of snares made of twisted rawhide. Several caribou, he said, had been snared in the fall of 1926, but this method had been abandoned by all but old men and hunters out of ammunition.

There are thus abundant evidences of man's interest in the caribou. Though influenced by the changing economic and social conditions in the Territory, the interest in these animals, and its importance, continues. As a game resource and as a possible means of improving the reindeer herds they are today of great value. For proper administration of this game resource, and for its better conservation, information has been needed about the migration of the herds in the middle-eastern part of Alaska, which is their stronghold, and concerning the range of caribou in other parts of the Territory. Such information is needed all the more in view of the economic development of Alaska, and especially in connection with the progress of the reindeer industry.

THE PRESENT STUDY

The present study of the caribou was undertaken to provide the information needed in administering this natural resource of the United States in Alaska. One of its definite objects was to obtain data bearing on the desirability of crossing the wild animals with the domesticated reindeer, with a view to improving the latter. Accordingly in the summer of 1920 the Bureau of Biological Survey established its Reindeer Experiment Station on the Bering seacoast, in the heart of the domestic reindeer country, and the writer was stationed in the interior, with Fairbanks as headquarters, instructed to make a thorough study of the wild caribou.⁴

About 3½ consecutive years were spent on the work, from July 1920 to December 1923, and subsequently three summer trips and a

³ Citations in parentheses refer to the Bibliography, p. 83.

⁴ E. W. Nelson, then Chief of the Bureau of Biological Survey, personally supervised the establishment of these various lines of research, and continued to direct the caribou investigations personally. The writer thus received the benefit of Nelson's pioneer experiences in Alaska, dating back to 1877. The valuable suggestions offered by him, his insistence upon success, and his full appreciation of the difficulties involved were conducive to efficiency in the work.

short winter trip were made to various parts of the Territory. During this period all the principal caribou ranges were visited—with dog team in winter, motor boat or poling boat in summer, and occasionally afoot in the hills, with pack dogs when other means of transportation were lacking. A few domestic reindeer herds were visited for comparative study. At all times the writer received from travelers, prospectors, hunters, Indians, and Eskimos much valuable information, which was checked against personal observations and verified from several angles. The Alaskans who so willingly gave information from their own experiences, and other assistance, sometimes at considerable inconvenience to themselves, deserve much credit, and not least among these are certain Eskimos who by their willing help furthered the work considerably.⁵

While the study was confined principally to Alaska, it became necessary to give considerable attention to Yukon Territory, since both areas are almost equally involved in the caribou migrations. It was impossible, however, to cover parts of Yukon in as great detail as Alaska.

Although the literature has been extensively examined for information on caribou, much of it was found to have little bearing on the particular problems involved, and no attempt is made to include a complete bibliography (p. 83). The report is based largely on information obtained in the field.

STATUS AND ABUNDANCE OF CARIBOU

Since the purchase of Alaska from Russia in 1867 the caribou herds have vastly decreased over a large part of the Territory, but with a few exceptions they are now doing well. Although they are gone from Kenai Peninsula, are dwindling on the Alaska Peninsula, and are disappearing from what is now the range of the reindeer, the principal herds of the interior are thriving. In recent years caribou appear to have been increasing in the Colville River region, and with the cooperation of Alaskans and others this condition should continue.

There has indeed been much speculation as to the number of caribou in the Alaskan herds and much disagreement over various estimates. Enthusiastic observers speak of "millions" or of "countless thousands." These estimates are usually based on general impressions, but it is difficult to find any other basis. When one considers the large territory occupied by caribou, the scattered distribution, and the almost constant and erratic movements of the animals, the difficulty of making a caribou census becomes evident.

⁵ As a rule the writer conducted the work alone, although on special occasions he employed local assistance. He was most ably assisted by his brother, Adolph Murie, for 18 months, a period that included one of the hardest winter trips, in the Endicott Mountains. The writer's wife also assisted materially by making botanical collections and by acting as cook on 1 winter and 1 summer trip. Identification of plant collections was made by G. K. Merrill, of Rockland, Maine; R. S. Williams, of the New York Botanical Gardens; and Paul C. Standley, of the United States National Herbarium. The Bureau of Animal Industry examined material in connection with studies of diseases and parasites. Stomach contents were determined by the Food Habits Research Section of the Biological Survey. At the University of Michigan A. G. Rathven and L. R. Dice facilitated the work of preparing the manuscript by many courtesies. The writer is also indebted to his colleagues in the Biological Survey for help in many ways. The results attained could not have been realized without the cooperation of the many who were in a position to give assistance.

Accounts by travelers who have seen large herds vary in details. It is common to hear of "whole hillsides moving with caribou", or of a herd "passing for hours." From such accounts it is difficult to form an accurate idea as to the concentration of animals in the herds observed. Never fortunate enough to see the enormous herds reported by others, the writer encountered frequently bands of 50 to 500 or 600, and on one occasion watched a herd numbering 2,500 by actual count (p. 44). Many of the animals in this herd were scattered over a barren, snowy hill, giving it the appearance of a slope thinly covered by scrubby spruce. One would expect that it would take immense numbers to produce such an effect, yet the animals on this slope were only a part of the 2,500 under observation, and this is not a large number for the heart of the caribou country.

In 1921 the author estimated the numbers in the Yukon-Tanana herd during the migration in the fall of 1920, using data obtained directly and from reports of other observers. The southeast migration of the herd covered a strip approximately 60 miles wide, 40 miles representing the part traversed by the main body and 20 miles that covered by scattered bands. The herd took about 20 days to pass one spot. During 8 of the 20 days about 1,500 animals in the main herd passed each day over a 1-mile strip and during the remaining 12 days about 100 animals a day. On this basis, the following computation was made:

1,500 a day for 8 days-----	12,000
100 a day for 12 days-----	1,200
	13,200
Total on 1-mile strip-----	13,200
Total on 40-mile strip-----	528,000

Allowing an average of 100 a day per mile for 20 days over the 20-mile strip traversed by scattered bands, one computes that 40,000 represents the additional number passing at the edges of the "run." The final estimate then is as follows:

Main herd-----	528,000
Scattered bands-----	40,000
	568,000
Total in Yukon-Tanana herd-----	568,000

In the light of subsequent experience this figure seems conservative and it is safe to say that the herd numbered well over half a million, possibly much nearer a million.

There is a peculiarity of the usual migration in the area between Fairbanks and Circle that needs explanation lest it may mislead anyone estimating its magnitude. The season of 1920 was typical. The animals, when they first appeared, were traveling northward, their route lying well back toward the main divide. Upon reaching the White Mountain district, near the Yukon, however, they swung about and doubled back on a return journey, this time on a route nearer Fairbanks. At one stage of the run some were thus going northwest while others were returning by a parallel course. Several travelers passing between Fairbanks and Circle noted this, finding the caribou traveling in one direction over a part of the area and in the reverse direction farther on. To avoid duplication, only a single route of the animals was considered in the above calculation.

The Yukon-Tanana herd is by far the largest herd included in this study, but the other herds would add many thousands to the total for Alaska and Yukon Territory together. This total, then, may number anywhere from 1 to 2 millions.

LIMITATIONS ON ABUNDANCE

THE REINDEER INDUSTRY

The caribou's greatest menace is not the wolf, nor the hunter, but man's economic developments, principally the raising of reindeer. Wherever reindeer herds are introduced, caribou must of course disappear, for both cannot occupy the same range. The disappearance of the caribou along the Bering Sea and Arctic coasts, while regrettable, was unavoidable in view of the development of reindeer herding in this section, which is ideal for the purpose. In considering eastern Alaska, however, a different viewpoint is permissible. This region is less suitable for effective handling of reindeer, and the ranges are already occupied by thriving herds of caribou, numbering many thousands, a public resource of considerable proportions and a boon to the prospector and traveler. Since reindeer and caribou cannot exist together, it is wise to designate certain areas in which each may develop—one part of the Territory in which the reindeer industry may develop its possibilities and another part in which the caribou herds may be maintained as a public resource. Both are of incalculable value to Alaska, and neither should be sacrificed in any misguided attempt to combine them.

The mingling of reindeer with the main caribou herds should be avoided. Reindeer herds maintained in close contact with migrating caribou suffer frequent losses through strays. Already the domestic reindeer are mingling with the caribou herd of Mount McKinley National Park, and A. M. Bailey and R. W. Hendee (1926, p. 22) report that large numbers of reindeer mingle with the caribou of the Arctic slope, with inevitable hybridization. Such a possibility would be regrettable in interior Alaska, which has produced a splendid type of wild caribou, coming near at least to being the largest on the continent.

As a game resource these interior Alaska herds should be kept pure, and as the principal herds now remaining are international in range, passing back and forth with the seasons between Yukon Territory and Alaska, concerted action by Canada and the United States would seem necessary for the proper administration of this resource. Flexible regulations are needed to meet changing circumstances, and accordingly it is necessary to keep in close touch with the condition of the herds at all times. The present status of the caribou is not permanent but variable, especially in view of possible economic developments in Alaska. Caribou require much territory, because of the nature of their winter food, and it would not be wise to permit overcrowding of the range. A serious decrease in numbers should also be guarded against as Alaska becomes more thickly settled and many of its frontier conditions pass. In the more densely populated parts of the United States we are learning that in the agricultural development of this country we have

made inadequate provision for big-game range. Such a condition should be forestalled in the course of the economic development of Alaska.

PREDATORS

Accurate information is lacking on the extent to which predatory birds or animals live on caribou. For a proper understanding of the relations existing between a game animal and its enemies, it is not sufficient to know merely that a certain species will prey on these animals. It is necessary to know as far as possible to what extent the game animal serves as food for the predator. Such information is largely lacking in the case of the caribou. Even the activities of the wolf are somewhat shrouded in mystery, and it is not certain what is the age or condition of the animals that this predator takes from the herds.

WOLVES

The northern timber wolf is the chief natural enemy of the caribou. It is extremely difficult to obtain definite information on the effect of these predators on caribou, and while there is much guesswork, it is well known that the wolves follow the caribou herds. In the upper Fortymile region during the latter part of the winter and the spring of 1921, for instance, the writer observed that during an unusual scarcity of caribou in the region, wolves also were not plentiful. A few tracks were seen, but there were not enough to cause special comment. The following winter, when caribou were numerous in this locality, wolves were much more in evidence, and many stories of their abundance circulated.

During the writer's travels over the caribou range wolves were never alarmingly numerous, although more recently they have been seen in greater numbers. It is not likely that predatory animals have been the chief factor in controlling the numbers of caribou. Many species have been found to increase to a certain limit, then fall off in numbers, in regular cycles—because of disease in some cases at least. Possibly caribou are subject to the same influence. Climatic conditions and food supply are no doubt important factors. Since the coming of the white man the killing of wolves has been offset more or less by the killing of caribou. Yet in recent years the caribou appear to be on the increase in some localities.

COYOTES

Since the time of these investigations coyotes have been reported as increasing in Alaska. Eventually they may become a factor in caribou mortality, but the degree to which they prey on caribou fawns is unknown.

BEARS

It is not likely that bears kill a great number of caribou, though they probably capture a few. The owner of a reindeer herd near Flat, Alaska, who had observed carefully the effect of predatory animals on his herd, informed the writer that he did not consider the black bear a serious menace, though he had suffered some losses from grizzlies. Reindeer are less alert than the wild caribou and have no doubt lost much of their agility, thus being an easier prey.

Another observer related an incident that shows at least that the bear has the inclination to pursue these animals: A black bear chasing a small group of caribou on a hillside was easily outdistanced by the caribou. The bear made several dashes for them, but each time they evaded it easily, and then stopped to look back. This continued for some time, until the bear turned to eating blubberies. When caribou are lying asleep (p. 29) they should be an easy prey for a prowling bear, but such an opportunity probably is not frequently offered. The new-born fawns are so precocious that their mortality from bears is no doubt low, compared, for instance, with that of moose calves.

LYNXES

Occasionally the lynx becomes a formidable enemy of caribou. This animal is known to kill reindeer and even mountain sheep in times of stress, and it has been stated that it attacks even full-grown caribou. Instances that have been related indicate that such attacks occur when rabbits have disappeared and the lynxes are desperate. At such times they even attack each other in their craze for food. It is thus extremely unlikely that under normal conditions the lynx will prey on caribou to any great extent.

WOLVERINES

The wolverine is credited with many misdeeds, but unfortunately little is known about this animal and there is little direct observation on its habits.

EAGLES

Both golden and bald eagles occur in interior Alaska, the golden eagle predominating, and it is presumed that these birds kill some of the caribou young. According to a reindeer owner at Flat, bald eagles kill fawns at times. They have not, however, been observed making the attacks, but have been found eating the carcasses, and in one instance it was known that the fawn had died from another cause.

DISEASE

No opportunity during this investigation was had to make a careful study of caribou diseases, but none of the observations made indicated that these animals are subject to disease to a serious degree. Seymour Hadwen and L. J. Palmer (1922) discuss various diseases and parasites found among the domestic reindeer, and some of these may occur in caribou. They found, however, that in a number of cases conditions were aggravated by close herding, and it is therefore probable that the caribou—scattered over a wide territory—are much less susceptible to disease than are the reindeer. It may be noted here, however, that in the spring of 1925, on Unimak Island, a yearling was found blind in both eyes (p. 40), the cause not apparent. The animal was killed, and the eyes and other portions were preserved in formaldehyde. Examination of this material by the Bureau of Animal Industry indicated that deep ulceration or possibly abscess formation had resulted in perforation of the cornea. It was thought that this had been caused by infection with pyogenic bacteria following some sort of injury.

PARASITES

Of the few well-known parasites of caribou, probably the worst are the warble fly, *Oedemagena tarandi*, and the nostril fly, *Cephanomyia nasalis*.

The warble fly deposits its eggs on the hair of caribou; the larvae hatch, bore through the skin, and migrate to the back region, where they develop just under the skin, until they finally work out and drop to the ground, producing the familiar perforated skin condition. In July and August, the active egg-laying time, these flies cause the caribou much uneasiness. Although the fly does not sting, the animals fear them and stand in a strained, alert attitude, stamping a foot or shaking the head when one hovers about. It would be interesting to know to what extent the animal is able to avoid these attacks by such vigilance. The writer has seen a caribou suddenly run for more than a quarter of a mile, then abruptly drop on a sand bar, in the shelter of a steep bank, and remain there quietly for a long time. Such flight is probably effective, if long enough and in the right quarter of the wind, for the flies probably hunt by scent.

On one occasion, while traveling overland with a companion, using several dogs as pack animals, the writer noticed a warble fly buzzing along behind the dogs, flying along until it caught up with the rear dog but not alighting. Presently the fly seemed to become fatigued and lit on the ground. When the dogs were some distance ahead the fly again took up the chase and soon was hovering about the dog once more. This procedure continued for some time, leaving the impression that the fly was fatigued each time it dropped to the ground, and that after a period of rest it again followed the scent of the animals. In the absence of caribou, the fly probably was somewhat attracted by the scent of the dogs but not to the extent of laying eggs.

The nostril fly deposits its larvae in the nostrils of the caribou, and they finally lodge in the soft palate, in the posterior part of the mouth cavity. In spring they become very noticeable and appear as a tightly packed wad of larvae, the writer in one case having counted 125 in the throat of one animal. In April caribou were seen coughing repeatedly for some time, apparently as a result of such irritation. The larvae drop out probably in May.

The bladder worm, the encysted form of *Taenia hydatigena*, is found in the liver of caribou, appearing on the surface as small white pimples. Several of these may sometimes be found in one liver. Another tapeworm, *T. echinococcus*, becomes encysted in the lungs, producing a hard lump that may be several inches in diameter and can be felt in the lung tissue. If dissected out, this lump appears as a globular body filled with fluid.

In the head of a caribou on Unimak Island a linguatulid, or tongue worm, was found, apparently the first record of the occurrence of the adult form of this parasite in a large mammal.

A yearling caribou taken on Unimak Island in May 1925 was found to have lungs speckled in places with purple spots, each with a red rim. Submitted to the Bureau of Animal Industry for examination, the lung proved to be infested with the eggs of a hair lungworm, thought to be *Synthetocarbuis*.

Hadwen (1922) examined one caribou infested with the cysts of the protozoa *Sarcosporidia*, which produced a "pitted" appearance on the surface of various bones and tendons and which he named *Fibrocytis tarandi*.

MOSQUITOES

Though not even a potential limitation on caribou abundance under present conditions, mosquitoes are generally considered a serious pest for the animals and an important factor influencing their movements (p. 46). Observations made during this study, however, are not conclusive on this point. In the midst of the mosquito season caribou were found in low, swampy country, as well as up among the glaciers. Local herders state that the domesticated reindeer suffer greatly from mosquitoes at times and consider that the caribou probably would not differ from the reindeer in this respect. Personal observations, however, indicate that the caribou is annoyed less by the mosquito than by the warble fly. The interpretation of a wild animal's behavior often requires nice judgment, and in considering other factors also, the writer has always felt that he could not determine to what extent the mosquito influenced the actions of the caribou, notwithstanding the fact that in literature it appears to be accepted as a fact that since the mosquitoes harass the caribou greatly they actually influence the animals' movements to an important degree.

GENERAL DESCRIPTION OF THE CARIBOU⁶

The caribou, a member of the deer family, belongs to the ruminant group of the even-toed, hoofed mammals. Like other ruminants, it has four compartments in the stomach and lacks upper incisor teeth; as one of the deer family it has deciduous antlers, lacks a gall bladder, and has other less easily defined characters.

On the other hand this animal is distinct in several respects. It belongs to the only genus in which both male and female normally carry antlers. Circumpolar in distribution and ranging farther north than any other deer—General Greely gives latitude $82^{\circ}45'$, on Grinnell Land, as probably the caribou range farthest north (MacFarlane, 1906)—it has developed several adaptations for life in the Arctic. In the deer family only the moose, itself a specialized animal, invades the southern parts of the caribou range to any appreciable extent. The heavy moose combats deep snow conditions with long legs; the lighter caribou has hoofs adapted for traveling over the surface of the snow.

The caribou's hoof, showing one of the animal's most interesting adaptations, are wide and rounded, forming a blunt-toed track (fig. 2). Such a structure is well adapted to carrying the animal on snow or swampy ground. The hoofs also are concave, with sharp outer edges useful in traveling over ice or frozen ground (fig. 3.). When the caribou is standing, its front hoofs project so far forward that the pasterns come near the ground. The tracks of the front feet (more rarely those of the hind hoofs, which are more nearly in line with the legs) often show the imprint of the pasterns if the animal

⁶ For discussion of taxonomy, see p. 73.

has been traveling over snow or other soft surface. The hoofs' characteristic clicking sound, accompanying the travel of caribou, is well known and is described by Ernest Thompson Seton (1927, v. 3, p. 69) as coming from the ankle joint, produced in some way by the shifting of tendons.

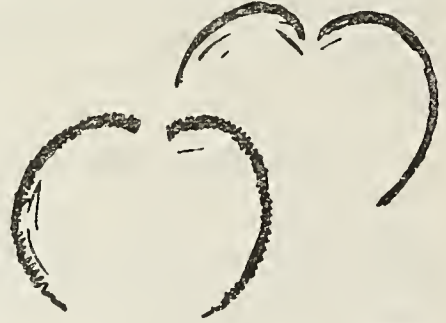


FIGURE 2.—Caribou tracks on soft surface.

B5448M

SIZE AND WEIGHT

In size and weight the caribou is intermediate between the mule deer and the elk, approaching nearer the mule deer. The Alaska-Yukon caribou are larger than the domesticated reindeer introduced into Alaska from the Old World (pl. 3, 4), but the data available on the reindeer are not precisely comparable with those on the caribou. According to miscellaneous accounts in the literature, few of which, however, are precise in this respect, the Alaska-Yukon caribou also appear to be somewhat larger and heavier than the caribou east of the Mackenzie River. In fact, on the basis of the available measurements and weights, it seems highly probable that the caribou of Alaska and Yukon Territory are among the largest on the American continent, being exceeded only slightly by the caribou in parts of British Columbia. There is much individual difference, some animals attaining a larger size than others at the same age. Seasonal variations are also great. An old buck, for instance, is much heavier in September than in winter.



B5449M

FIGURE 3.—Caribou tracks in thin layer of snow on ice.

SIZE

Field measurements, though too few for satisfactory comparisons, indicate that the caribou of Alaska Peninsula are slightly smaller than those of interior Alaska and that the latter, in turn, are somewhat smaller than those of British Columbia. The total length of interior Alaska caribou, males, averages about 2 meters, or about 78 inches. The length of caribou of lower British Columbia averages 2.123 meters, or 83½ inches. The shoulder height of all the caribou considered varies from 1.169 meters or 46 inches, to 1.397 meters or 55 inches. In using



B24358; B20291

A, A young caribou buck among domestic reindeer, showing the caribou's longer legs and rangy build.
B, Buck caribou in September, after acquiring winter pelage and shedding the velvet.



these figures, however, it must be remembered that field measurements of large mammals vary with the conformation of the ground on which the animal lies and with the technic of the collector (table 1).

TABLE 1.—Field measurements of caribou bucks

Specimen number ¹	Species and locality	Date collected	Total length	Length of tail	Length of hind foot
	<i>Rangifer arcticus granti</i> : ³		<i>Mm</i>	<i>Mm</i>	<i>Mm</i>
(2)	Unimak Island, Alaska.....	Apr. 30, 1925	1,905	203	521
(2)	Izembek Bay, Alaska.....	July 19, 1925	1,918	166	556
	<i>R. a. stonei</i> :				
244310	Savage River, Alaska.....	Aug. 10, 1923	1,965	160	605
243629	do.....	Oct. 21, 1922	2,080	162	605
243628	do.....	Oct. 19, 1922	2,040	150	595
244313	do.....	Oct. 4, 1923	1,905	165	623
242730	Mount McKinley National Park, Alaska.....	May 2, 1922	2,121	152	600
244317	McCarty, Alaska.....	Oct. 11, 1923	1,982	165	584
236578	Chena River, Alaska.....	Sept. 30, 1920	2,040	174	590
236574	do.....	Sept. 14, 1920	2,120	144	605
236575	do.....	Sept. 15, 1920	2,110	133	587
236576	do.....	do.....	2,090	140	615
236577	do.....	Sept. 21, 1920	2,000	152	590
246351	Upper Koyukuk River, Alaska.....	Oct. 29, 1924	1,735	150	525
(2)	do.....	Nov. 1, 1924	1,875	160	550
(2)	Old Crow River, Yukon Territory.....	July 13, 1926	2,000	180	590
	<i>R. a. osborni</i> :				
206348	Sheep Creek, Dease River, British Columbia.....	Aug. 5, 1914	2,110	180	625
171092	Iskut River, British Columbia.....	July 30, 1910	2,140	140	660
171093	Klappan River, British Columbia.....	Aug. 22, 1910	1,931	178	648
180244	Laurier Pass, British Columbia.....	Sept. 7, 1912	2,000	170	700
206349	Walker Creek, near Dease River, British Columbia.....	July 21, 1914	2,180	150	670
	<i>R. montanus</i> :				
244187	Bull Moose Creek, British Columbia.....	Sept. 1, 1923	2,083	127	(4)
209409	Big Salmon River, British Columbia.....	Sept. 1, 1915	2,268	218	630
244185	Middle Pine River, British Columbia.....	Aug. 31, 1923	2,122	114	(4)
244184	do.....	Aug. 28, 1923	2,019	140	(4)
246293	Wapiti River, British Columbia.....	Sept. 21, 1925	⁵ 2,210	(4)	(4)
245612	Sheep Creek, northeast British Columbia.....	Sept. 10, 1924	⁶ 2,058	(4)	(4)

¹ In Biological Survey collection.² Specimen not in Biological Survey collection.³ For nomenclature of Alaska forms, see pp. 74 to 83.⁴ Not available.⁵ Approximation.

WEIGHT

In the course of the present study there were occasional opportunities for weighing caribou, and additional information was offered by others who had weighed the animals. The data thus obtained are given in table 2, dressed weight, unless otherwise indicated, representing the carcass as ordinarily prepared for food, after removing entrails, head, feet, and hide.

Of 18 adult bucks, the average dressed weight was 247 pounds, the heaviest 305, the lightest (a 3-year-old) 190. Of six adult bucks, the average live weight was 366 pounds. Some higher figures have been reported, and if a larger number of weights were obtained possibly a higher average would result.

Of 12 adult does the average dressed weight was 148 pounds, which is probably a fair figure. The average live weight of 5 adult does was 213 pounds.

Few fawns or yearlings were weighed. One male fawn in September weighed 75 pounds dressed, another 121 pounds live weight.

TABLE 2.—Weights of Alaska caribou

BUCKS

Locality	Date	Age	Condition	Live weight	Dressed weight
				<i>Pounds</i>	<i>Pounds</i>
Delta River ¹	May 7, 1921				255
Do. ²	Aug. 11, 1921	Adult	Poor		260
Savage River ³	Oct. 19, 1922	Old	do	360	217
Do. ³	Oct. 21, 1922	do	do	372	230
Do. ³	Aug. 10, 1923	3 years			190
Toklat River ³	Dec. —, 1920	Old			⁴ 246
Do. ³	do.	do.			⁴ 254
Beaver Mountains ⁵	Sept. 25, 1918	Adult			305
Do. ⁵	Apr. 20, 1920		Large frame		260
Do. ⁵	do.	Adult			230
Faith Creek ⁶	Sept. —, 1919	do.			⁴ 280
Do. ⁶	do.	do.			⁴ 275
Chatanika River ³	Sept. 20, 1921	Old			268
Chena River ³	Sept. —, 1920	do.		374	260
Do. ³	do.	do.		366	240
Do. ³	do.	do.		372	240
Do. ³	do.	do.		352	230
Do. ³	do.	do.			⁴ 212
Average				366	⁷ 247

DOES

Delta River ¹	Dec. 9, 1921		Fair		190
Do. ¹	do.		Fat		220
Do. ¹	Dec. —, 1921				166
Savage River ⁸	Oct. 19, 1922	Rather young		186	100
Do. ⁸	Oct. 20, 1922			220	128
Do. ³	Oct. 18, 1922	Adult		250	136
Kuskokwim River, South Fork ¹	Feb. —, 1922	do.			177
Do. ³	do.	do.			145
Chatanika River ³	Sept. 17, 1921	Old			143
Do. ³	Sept. 21, 1921	Adult		216	128
Do. ³	Sept. 23, 1921	do.		194	125
Tanana Crossing ³	Apr. —, 1921		With calf		120
Average				213	148

¹ Data obtained by Frank Glaser.² Data obtained by Theo. Lyman.³ Data obtained by the author.⁴ Includes hide.⁵ Data obtained by A. H. Twitchell.⁶ Data obtained by C. T. Glascock.⁷ Including 5 with hides.⁸ Data obtained by Adolph Murie.

PELAGE

In September and October, when caribou are at their best, the pelage is fresh and fully grown, and only at this season can comparable specimens be obtained; at other times wear and fading are likely to result in great variation.

BUCKS

In September a normal old buck appears, at a little distance, dark brown in body, with a white neck and long white beard, the white extending back over the point of the shoulder and continuing as a band along the sides (pl. 3, *B*). When the feet are visible a white rim appears above the hoofs, extending up the foot some distance posteriorly. This is the uniform by which the old caribou buck may be recognized in the field. The brown ground color varies in different lights, sometimes appearing very dark, at other times much paler.

Close examination of the autumn pelage shows that the general body color is cinnamon brown with an element of cinnamon drab, approaching Prout's brown on the legs. The color is paler and more grizzled on the back and thighs and darker on the front of the legs; the inner surface of the thigh is a pale, vinaceous buff. The shoulders are grizzled white, and a whitish lateral stripe extends from shoulder to thigh. The area below this lateral stripe is darker than the back, grading into a still darker shade ventrad and becoming paler on the midventral line. The ventral side is darkest on the chest, becoming grizzled caudad and shading into the white of the abdomen. The neck is white with a slight yellowish tinge and a white "beard." The top of the rostrum is dark chestnut brown, somewhat lighter posteriorly, to the forehead. The crown is paler, speckled with white hairs—or sometimes pure white. The cheeks are about the same color as the back. The nose, which is hairy, and the tip of the lower lip are white, with a slight greenish tinge caused possibly by vegetable stain. A few white hairs appear about the eye, sometimes numerous enough to form a definite white ring.

There is great variation in the extent of the lateral stripe. When most highly developed it is a broad continuation from the white neck, covering the anterior half of the shoulder and extending back along the side to the region of the thigh. The ventral border is definite and clear cut, but the dorsal edge fades out and becomes diffused in the coloration of the dorsal area. The lateral stripe is sometimes narrow, sometimes dull and indistinct, and it may be represented only by a patch of white just back of the shoulder.

Bucks up to the age of 2 years at least, possibly older, appear paler than the older bucks, the neck is light gray rather than shiny white, and the light flank stripe is duller and not so clearly defined. In other words, young bucks do not have the striking uniform of brown and white displayed by the older bucks.

DOES

In autumn, the adult doe, which then may be easily mistaken for a young buck, is colored much like the buck except that her pelage often appears paler throughout, the neck is gray rather than white, and the lateral stripe is not prominent. The chest also is likely to be lighter and the white of the abdominal region more extensive. Older does more nearly approach the coloration of the males in that the neck is more nearly white and the flank stripe more prominent than on younger females.

FAWNS

In September fawns have the general color of adults but lack the white neck, the flank stripe is only faintly indicated, and there is a general mixture of white hairs in the brown. The white band above the hoofs is not clear cut, and it shades broadly into the dark portion, with a generous sprinkling of white hairs extending a little distance up the foot. These scattered long white hairs are the outstanding feature of the fawn's pelage, which is more uniformly colored than that of the adults.

A 9-pound caribou fawn born at the Reindeer Experiment Station, Fairbanks, Alaska, as reported by L. J. Palmer, in charge of the

station, was "of a distinctly reddish color, as against the black color of the reindeer fawns, and with a black line about an inch and a half wide running along the backbone", the ears and part of the head "of a black color." Skins of unborn or new-born fawns observed by the writer in the hands of Eskimos in the Hudson Bay region varied from dark brown, almost blackish, to a distinctly reddish brown. No doubt a similar variation is present among the Alaska caribou.

CHANGES OF PELAGE

The pelage of young and old caribou of both sexes during winter undergoes much wear and fading. By spring much of the original brown has bleached out, and in May the animals have become nearly "dirty white"—brownish on close inspection, but apparently white at a little distance (pl. 4, *A*). They often have been mistaken for white mountain sheep at first glance. At this season also individuals vary. The older animals apparently retain their color to a greater degree than the younger stock, possibly because the pigmentation of the older animals is heavier and hence lasts longer. The writer has seen bucks in June that were still rather dark brown. In June new hair begins to appear, and in July the old worn coat drops out in shreds, leaving the animals ragged. Black areas appear irregularly over the body, where the new dark coat or the black skin is laid bare in shedding. Late in July and in August the new coat is acquired, first of all by the old animals. This new coat is dark, in some cases appearing slaty gray at a little distance, though many caribou in summer are distinctly dark brown rather than slaty. A little later this color gives way to the characteristic brown pelage of autumn, corresponding in this respect to the "blue" autumn coat of white-tailed deer.

At this stage the white neck and flank stripe have not yet appeared, even in large bucks, and the animals are uniformly colored (pl. 4, *B*). On some of the largest males a faint indication of the white hairs beginning to show through makes the neck paler, a dull gray. Close inspection also reveals an indication of the flank stripe. A little later these white hairs, which eventually attain a greater length than the rest of the pelage, become prominent and produce the characteristic flashing white neck and flank of the old bucks (pls. 5, *A*, and 3, *B*). Prime condition has generally been reached by the first week in September, younger animals lagging behind in this development.

VARIATIONS

There is great individual color difference, apparently not accounted for by age or sex. In one herd, for instance, some animals will differ from others of the same sex and approximately the same age. This was observed repeatedly, both in fall and winter. On October 29, 1924, on the Koyukuk River, three caribou were shot. Two of these were young bucks of about the same age. One had the normal brown color, but the other was much paler, appearing almost grayish in life and conspicuous in coloration as the little group came down the river. In summer also it was noticed that among animals of about the same age some may be in advance of others in the shedding of old hair and



B29909, B29531

A, Blind yearling caribou feeding on normal caribou forage by scent—the pelage has become pale and whitish, the characteristic color in spring. *B*, Captive caribou buck late in summer, before the white neck has developed.



B24120; B24140

A, Caribou buck in late-summer pelage, before the velvet is shed. B, Caribou buck in prime condition, with velvet rubbed from the antlers.

the acquisition of the new coat, which in that season greatly affects the general appearance of the animals. Another variation, in the extent of the lateral stripe on bucks, has been discussed on page 15.

One factor having an important bearing on apparent coloration is the position of the animal with reference to the light. One evening in February, for instance, the writer stalked a group of caribou on the skyline of a bald mountain. Those standing with heads pointed away from the observer appeared almost black, while those facing him reflected the sun's rays and appeared very light. There was almost the difference between black and white. As an animal turned it suddenly changed color.

In autumn a woolly growth often appears near the hips or along the lumbar region, particularly on old bucks. An unusual hide, from an old buck shot on Eagle Creek, east of Fairbanks, on September 20, 1915, and later examined by the writer had a pelage that in general was dull whitish or straw colored—lightest on the neck, shoulders, and sides, but not very dark even on the breast. Most of this pelage was covered by woolly hair, more particularly on the sides. The neck had been cut away, but it was said that the wool on that part had been sprinkled only thinly with coarse hair, which protruded. On the hips and shoulders the wool was thick and somewhat curly, having the appearance of the faded coat of a spaniel. The light-brown dorsal area was not so woolly as elsewhere.

This skin represents an extreme development of a normal condition. The woolly growth generally remains underneath the coarse hollow guard hairs, but is visible on the back and hips and to a less extent on the shoulders, where the shorter hair has permitted the wool to grow beyond its tips. E. R. Warren (1921, p. 173) describes a number of "buffalo robes" with silky, somewhat curly hair, a condition of pelage that was said to occur rarely. From another source he had obtained the information that ". . . the young buffalo bulls in November were said to be in the silk." "Woolly" caribou hides may be comparable.

Perhaps they may also be likened to the type of rabbit fur known as "rex", developed by rabbit breeders, in which the guard hairs are more or less suppressed and the underfur greatly developed.

ANTLERS

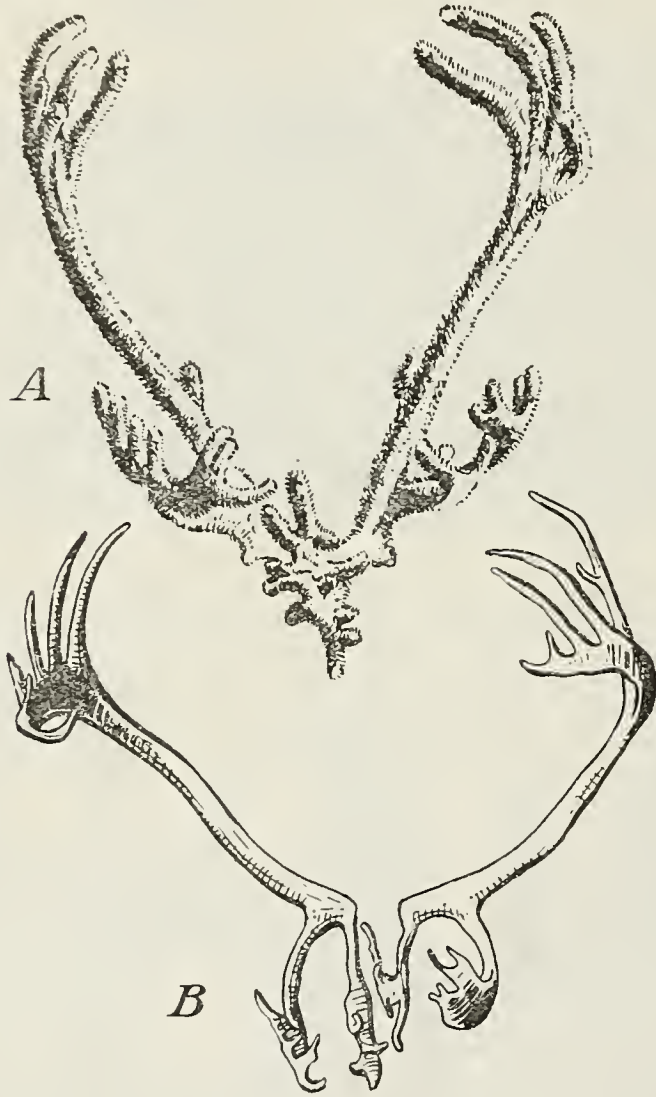
STRUCTURE

BUCKS

Caribou antlers are distinctly unlike those of other members of the deer family. Those of the full-grown buck are generally composed of two heavy main beams, each leading back from the forehead almost in a line with the rostrum, then sweeping upward with a more or less noticeable angle nearly half its length and curving forward near the tip; a pair of brow tines, either one or both flattened into a broad vertical "shovel", often reaching forward nearly to the nose; a pair of bez-tines, longer than the brow tines, and bearing lesser points near the tip; usually a small point or back tine at the posterior

angle of each main beam; and near the tip of the main beam, usually palmated, a series of points projecting from the upper edge. There may, however, be many variations within the same herd, and a number of more or less distinct types occur.

As to the shape and angles of the beams, the antlers appear to fall into two classes. The distinction is rather subtle and is more ap-



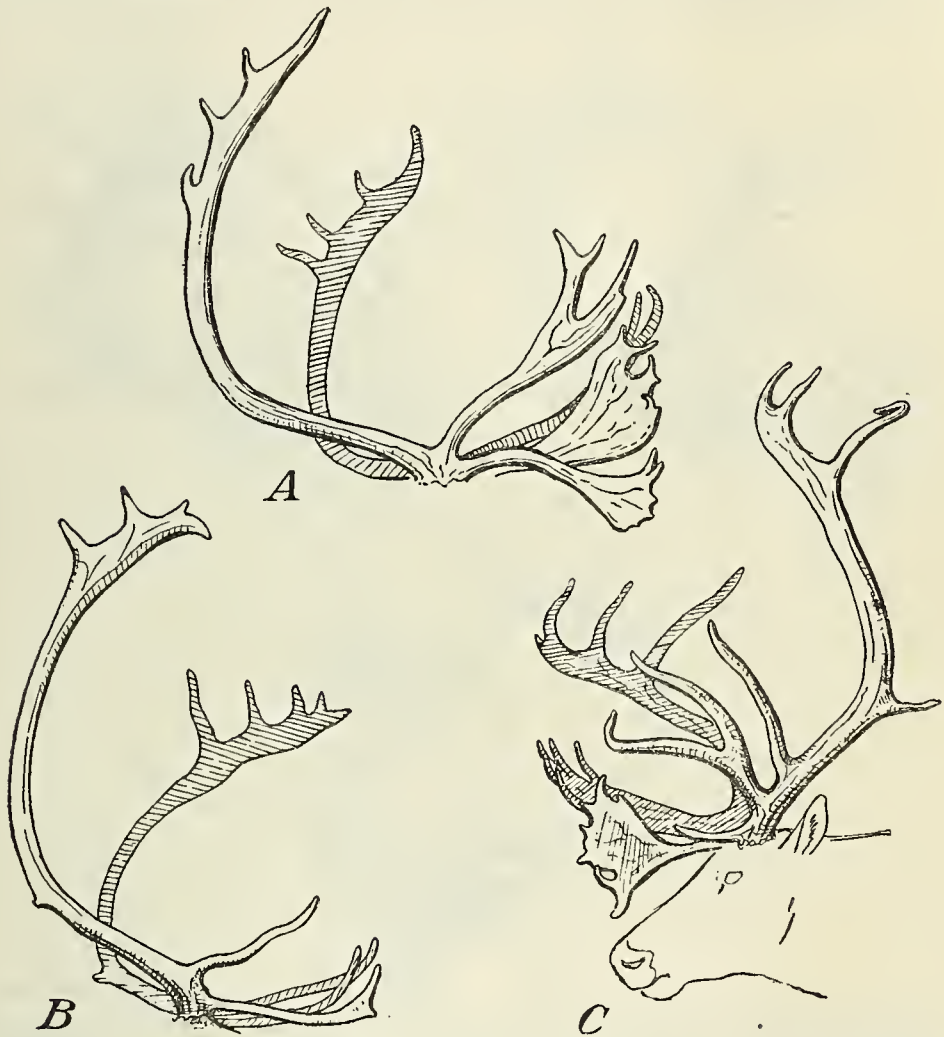
B6450M; B5451M

FIGURE 4. *A*, V-shape antler spread of caribou buck collected at Circle Hot Springs, Alaska, in August 1920 (length of beam, 36 inches; widest spread, 24 inches); *B*, wide, rounded type of antler spread of buck taken at Chena Hot Springs, Alaska, on October 15, 1920 (length of beam, 59½ inches; widest spread, 50 inches).

parent in a front view. From this viewpoint many antlers have a triangular appearance, as shown in figure 4, *A*. Antlers of the other class have a more widely diverging, less angular, aspect, as shown in figure 4, *B*, and are perhaps less common. Both kinds, however, occur plentifully in the same herd, with many intermediate gradations.

Caribou antlers may also be classified according to the form of individual antlers. For example, as to variation in the degree of palmation, three classes may be defined:

1. Round horns, with a minimum of palmation throughout (fig. 5).
2. Flat horns, in which the palmation occurs as a general flattening of the beam toward the tip (fig. 6).
3. Palmated horns, in which a definite, somewhat circular "palm" appears at the end of the beam and principal branches (fig. 7).



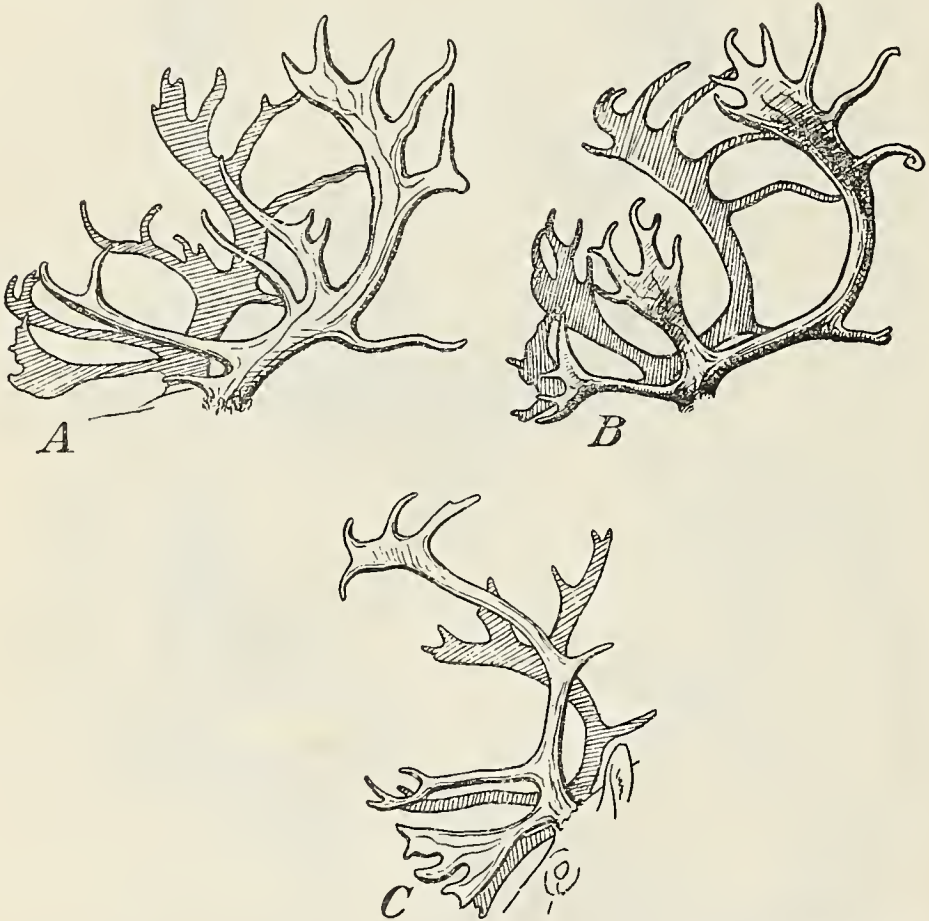
B5452M; B5453M; B6454M

FIGURE 5.—Round-horn antlers of caribou bucks: *A*, Collected along the Chena River, Alaska, September 17, 1920 (length of beam, $53\frac{1}{2}$ inches; widest spread, $35\frac{1}{4}$ inches); *B*, collected at the same place and time (length of beam, $47\frac{1}{2}$ inches; widest spread, $32\frac{1}{2}$ inches); *C*, collected along Twelvemile Creek, interior Alaska, September 18, 1921 (length of beam, $43\frac{3}{4}$ inches; widest spread, $33\frac{3}{4}$ inches).

These types are clearly discernible at a distance, when a band of bucks is silhouetted on the skyline. The flat brow tine occurs in all forms. Many intermediate forms are found, but any of the variations may occur within any herd or region, a fact that lessens the value of such features for use as taxonomic characters (figs. 8 to 11).

Unusual or abnormal growth sometimes appears. The back tine, normally very short, or even absent, may become unusually length-

ened, as in those shown in figures 6, *A*, and 7, *A*. The tip of the beam may take an odd form, or there may be an extreme flattening throughout the entire antler (fig. 6, *A*). The brow tine generally develops the flattened "shovel" only on one antler, the other being represented by a mere prong, but sometimes both brow tines develop the shovel. Figure 12 shows a depression or "cup" formed near the tip. In figure 13 is shown an odd pair of antlers from the Chandalar country, with an extreme horizontal spread of 71½ inches, probably a world's record for caribou.



B5465M; B5466M; B5457M

FIGURE 6.—Flat-horn antlers of caribou bucks taken in Alaska: *A*, From Chena River, September 21, 1920 (length of beam, 40½ inches; widest spread, 33½ inches); *B*, from Twelvemile Creek, September 18, 1921 (length of beam, 37 inches; widest spread, 24 inches); *C*, from Chena River, September 14, 1920 (length of beam, 31 inches; widest spread, 27 inches).

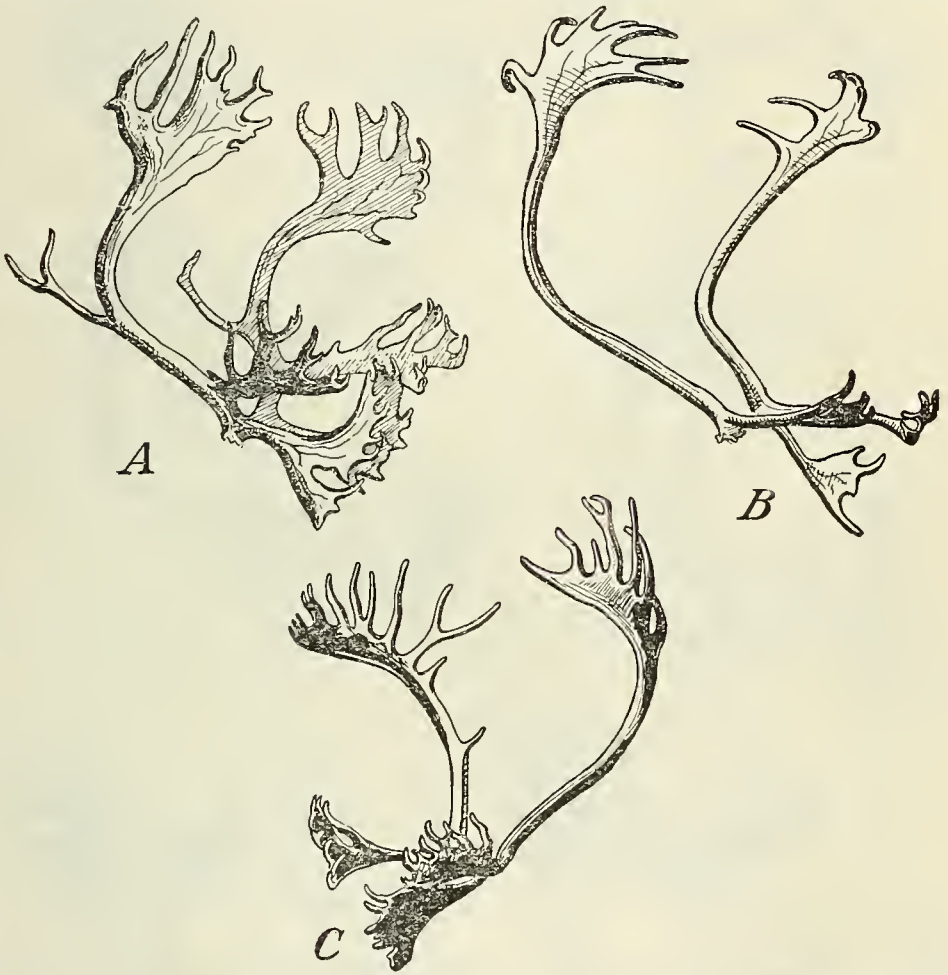
DOES

Alaskan caribou are normally antlered in both sexes and all ages. Hornless does, however, were reported to the writer on several occasions, and though he has never examined such a specimen closely, once, on the upper Chena River, he saw a doe without antlers, in September, when no caribou should have shed them. This animal was observed carefully with binoculars, and an unusually pale coloration was noted.

The antler of the doe is a smaller, less specialized replica of that of the buck. The brow tine is often only a round prong, or modified into a shovel much smaller than that of the male, and there is a tendency toward few points.

IMMATURE CARIBOU

The description of the antlers of adult does applies also to the antlers of young bucks. In young does the antler may be represented by a simple rounded beam and bez-tine, the brow tine being repre-



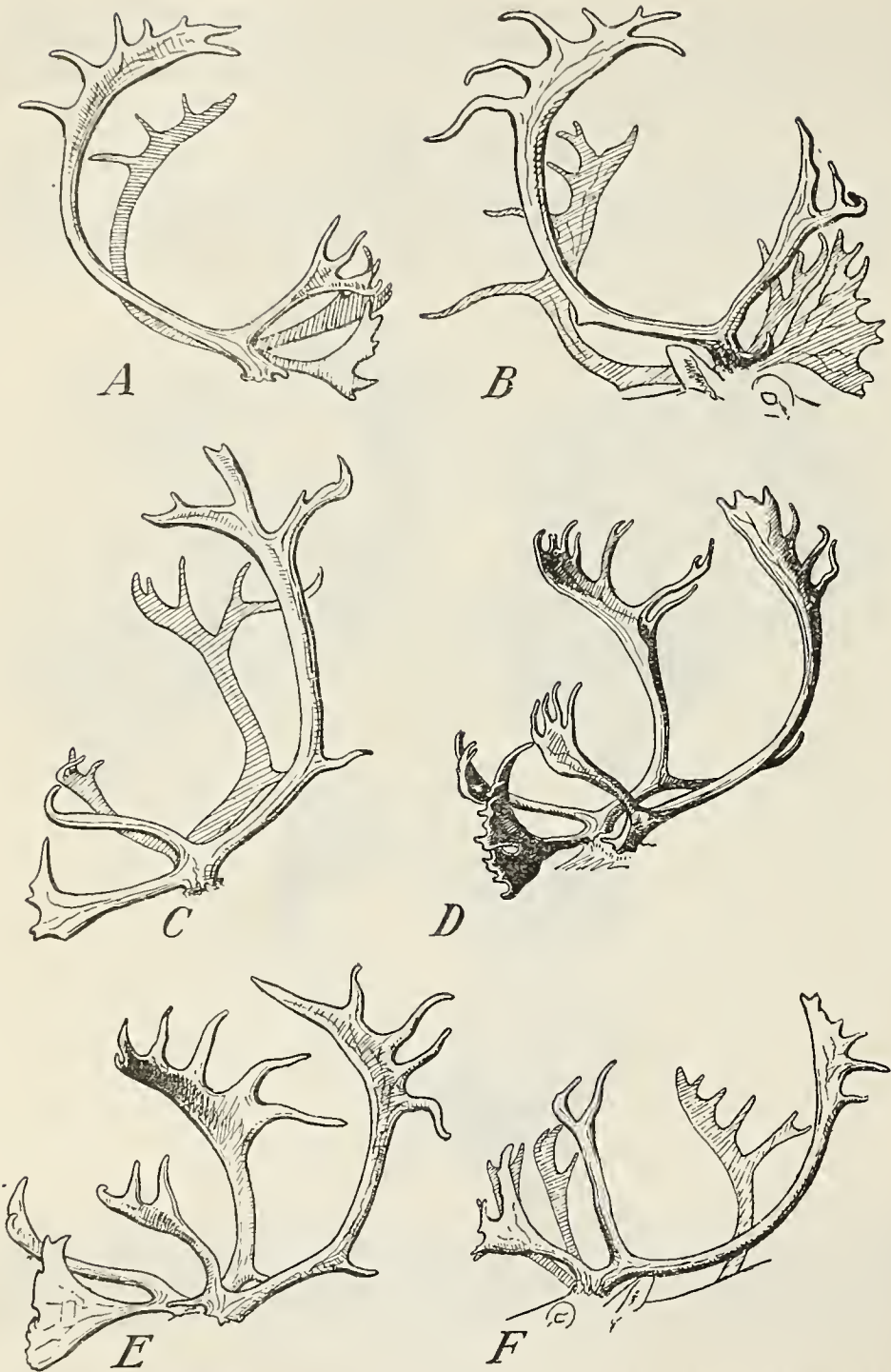
B6458M; B5459M; B5460M

FIGURE 7.—Palmated-horn antlers of caribou bucks taken in Alaska: A, From Chicken, September 2, 1919 (length of beam, 35 inches; widest spread, $32\frac{3}{4}$ inches); B, from Caro, 1922 (length of beam, $51\frac{1}{2}$ inches; widest spread, $37\frac{1}{4}$ inches); C, from Hot Springs Creek, Melozitna River, September 1922 (length of beam, 46 inches; widest spread, $38\frac{1}{2}$ inches).

sented only by a mere rudimentary knob. The fawn has a straight spike the first year, attaining a length of 8 or 10, but usually not more than 12, inches.

COMPARISON OF CARIBOU AND REINDEER ANTLERS

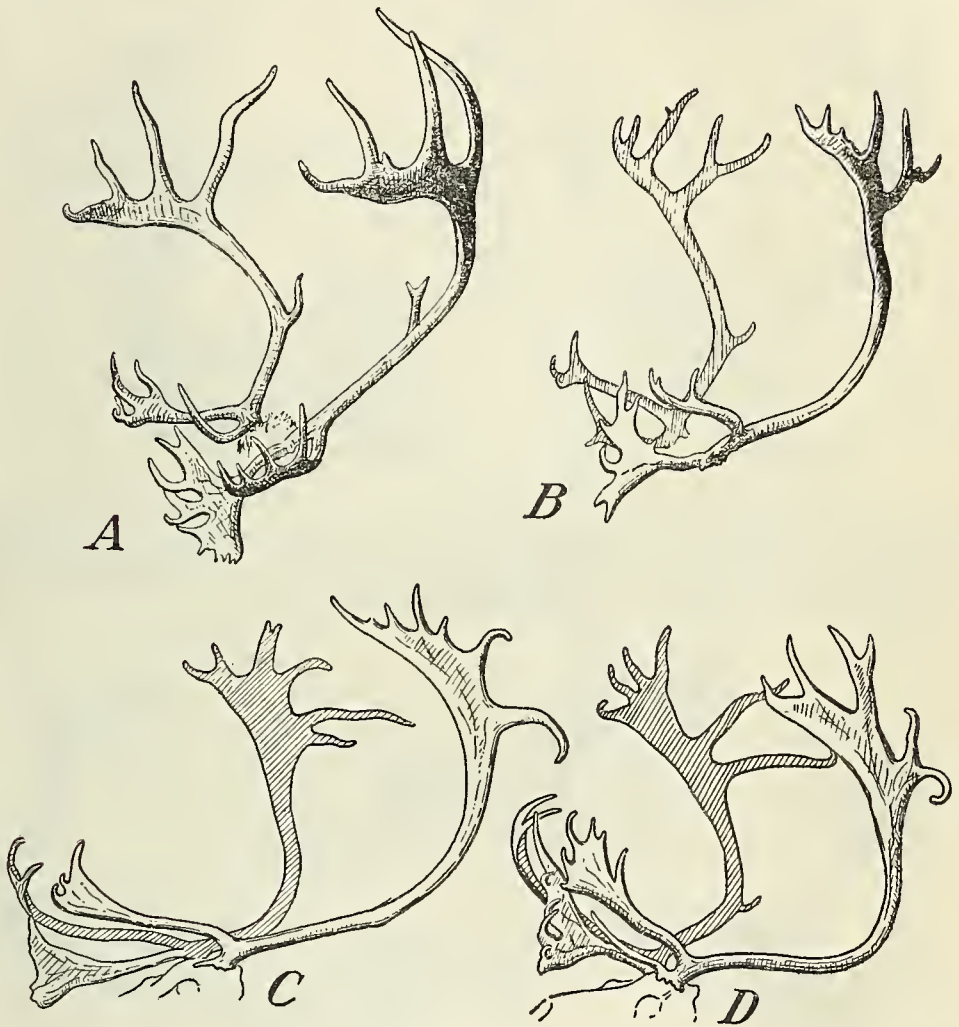
It is interesting to compare the antlers of caribou with those of the closely related Old World reindeer introduced into Alaska. Among the reindeer the antlers of the does are much more highly



B5461M; B5462M; B5463M; B5464M; B5465M; B5466M

FIGURE 8.—Varied antlers of bucks collected in the Chena River district, Alaska: *A*, September 17, 1920 (length of beam, $49\frac{3}{4}$ inches; widest spread, $25\frac{3}{4}$ inches); *B*, September 17, 1920 (length of beam, $43\frac{1}{2}$ inches; widest spread, $27\frac{1}{2}$ inches); *C*, September 14, 1920 (length of beam, $44\frac{1}{2}$ inches; widest spread, $25\frac{1}{2}$ inches); *D*, September 18, 1921 (length of beam, $47\frac{3}{4}$ inches; widest spread, 35 inches); *E*, undated (length of beam, 53 inches; widest spread, 28 inches); *F*, September 17, 1920 (length of beam, 46 inches; widest spread, $36\frac{1}{2}$ inches). See also figures 4, *B*; 5, *A* and *B*; and 6 *A* and *C*.

developed, carrying a greater number of points than do those of wild caribou does. As a matter of fact, in an ordinary reindeer herd there is not a great difference in the horns of the two sexes, the does often having even a well-developed brow tine of the shovel type. Probably if the bucks were allowed to reach the age of the does there would be a greater difference in size, as some old reindeer steers used



B5467M; B5468M; B5469M; B5470M

FIGURE 9.—Varied antlers of bucks taken from the northern herd of Alaska-Yukon caribou: *A*, From Chandalar River, Alaska, September 1922 (length of beam, $52\frac{1}{2}$ inches; widest spread, 47 inches); *B*, from Caro, Alaska, 1922 (length of beam, 39 inches; widest spread, 24 inches); *C*, from Rampart House, Porcupine River, Yukon, October 1925 (length of beam, $50\frac{3}{4}$ inches; widest spread, $32\frac{1}{2}$ inches); *D*, from Rampart House, Porcupine River, Yukon, October 1925 (length of beam, 47 inches; widest spread, $33\frac{1}{2}$ inches). See also figures 7, *B*, and 11.

for draft animals do grow large, heavy antlers. The unusual development of antlers in the reindeer, however, is shown not only by the numerous prongs and large brow tine of the female, but also by the branched antlers of the fawns. The writer has never observed more than a single spike on a caribou fawn; he has seen a reindeer fawn in its first summer with 7 points on its 2 horns; and 2 or 3 prongs are common.

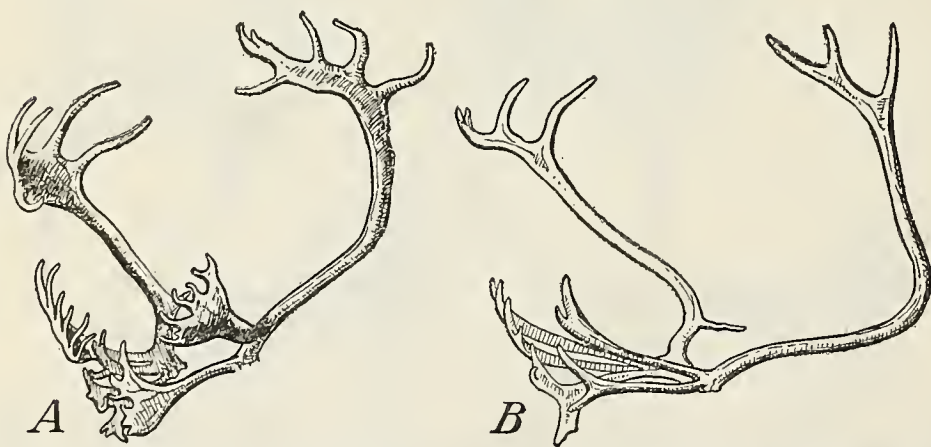
DEVELOPMENT OF ANTLERS

The growth and shedding of the caribou's antlers are somewhat coincident with the development and changes of pelage and, like the pelage changes, differ with sex and age and vary with physio-



B5471M; B5472M

FIGURE 10.—A, Buck antlers from Peluk Creek, Kuskokwim region, Alaska, taken in November 1925 (length of beam, $41\frac{1}{2}$ inches; widest spread, 30 inches); B, buck antlers from Jenny Creek, Mount McKinley National Park, taken October 25, 1920 (length of beam, $51\frac{3}{4}$ inches; widest spread, $35\frac{1}{2}$ inches).



B5473M; B5474M

FIGURE 11.—A, Antlers of buck taken near Nelson Lagoon about 1918 (dimensions not recorded); B, antlers of buck taken on Unimak Island, May 10, 1925 (length of beam, $42\frac{1}{2}$ inches; widest spread, $46\frac{1}{2}$ inches).

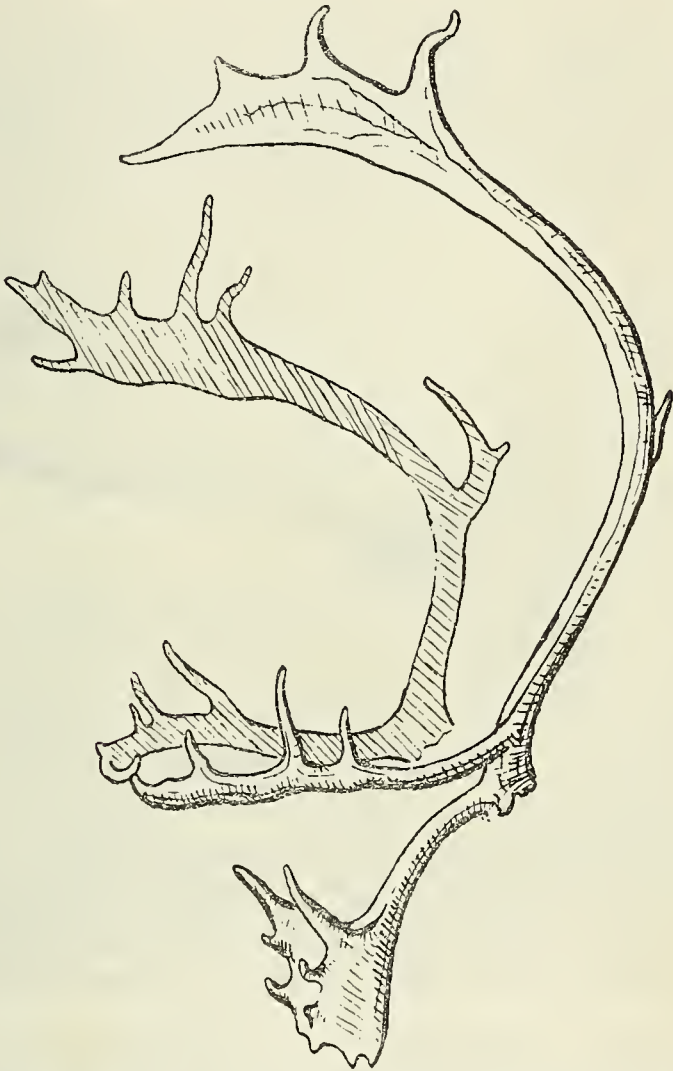
logical condition. Exceptions to the normal are not difficult to discover, but the ordinary sequence in antler development is described in the following paragraphs.

MATURE BUCKS

Old bucks not only form larger and more massive antlers than the females but also grow and shed them earlier. In interior Alaska, the writer has found old bucks late in April, with velvet knobs

well begun, and once on April 30 on Unimak Island a buck was shot that had antlers nearly a foot long. Considerable growth takes place during May and June, and in May the main branches appear. During July the lesser points develop, and the antlers take on their mature form, although the tips are still rounded and clublike.

Throughout summer when bucks are quiet, feeding, and fattening, their antlers grow steadily. At this time they are tender and



B6475M

FIGURE 12.—Unusual antlers taken from caribou buck at Chena Hot Springs, Alaska, October 15, 1920, having a depression or "cup" near the tip of shovel (length of beam, 48 inches; widest spread, 25½ inches).

the animals guard them carefully. A big buck going through the spruce woods in August was observed moving slowly, swinging his head cleverly this way or that, to avoid contact with obstructions, and when a bush or limb did catch in the curve of his horns, he slowly turned his head until the antlers were free. In August the circulation of blood in the antlers becomes more sluggish, until the supply is practically shut off. The oldest bucks then begin to rub

the velvet, and in the last few days of August or the first of September an occasional one may be found with bare horns, streaked with blood. Among animals of old age the velvet is shed more or less regularly early in September (pl. 5, *B*), and the writer has seen old bucks polishing their horns as late as September 23. Old bucks thrash the bushes and young spruces with their antlers until the velvet is rubbed off in bloody strips. On a still day the writer has often heard a scraping and clanking of antlers in scattered timber where one or more large bucks were engaged in mimic battle with willow bushes or young spruces. On one occasion a buck was prodding the ground with his antlers, although the velvet was already gone. When the velvet has been disposed of, the antlers are still smeared with blood, but continued rubbing soon brings them out clean and polished, and the buck has then reached his prime.



B5476M

FIGURE 13.—Odd antlers, with a record spread, from caribou buck taken on Chandalar River, near Fort Yukon, Alaska, April 15, 1923 (length of beam, 53½ inches; widest spread, 71½ inches).

The antlers of mature bucks are usually shed in November, the older animals shedding first. A prospector near the head of McManus, however, reported seeing on October 23, 1920, five large bucks, of which one had dropped both antlers and another had lost one. Many bucks also have been observed with antlers in December.

DOES AND IMMATURE ANIMALS

The process of the antler development of females and young males is somewhat different from that of older bucks. The young bucks may carry their old antlers until late in April, while does carry theirs until the middle of May, some of them until June, and often a doe may still have antlers when the fawns are born. Hence, these animals are much later in growing new horns and in shedding velvet. Old does are likely to drop the antlers a little earlier than younger ones, just as old bucks drop theirs earlier than young bucks, although in the latter case the difference is much greater.

It has been suggested that the purpose of the late shedding of the antlers of the female is the protection of the young, but this is

hardly probable. The antlers are dropped about the time the fawn is born, or even before, and in any case the hoofs are more formidable weapons than the antlers. Furthermore, young bucks and yearlings carry their antlers almost as long as do the does.

Yearlings and fawns of both sexes are also late in antler development, fawns, particularly, retaining the velvet even longer than many of the does.

USE OF THE BROW TINE

One frequently hears the opinion expressed that the well-developed brow tine, or shovel, of the caribou is used by the animal to scrape away snow in uncovering lichens (Thomas Pennant, 1784, and others), and it seems appropriate to include the numerous objections to this theory: Not all the animals have the shovels, and most of the does, fawns, young bucks, and even some of the older bucks do not have them well-developed. The work of scraping snow for the entire herd would thus devolve upon a small number of animals, and there are many caribou groups without any adult bucks supplied with shovels. Furthermore, the brow tine does not extend beyond the muzzle and thus could only be used awkwardly by the animal for this purpose. Observation during the present investigation failed to confirm the shovel theory, and on the other hand caribou were definitely observed scraping with their front hoofs, in the characteristic manner of others of the deer family that graze in winter.

TEETH

The teeth of the caribou are comparatively weak for so large a ruminant. Alike in both sexes, the dentition consists of no incisors, 1 canine, 3 premolars, and 3 molars on each side of the upper jaw. The lower jaw possesses on each side 4 incisors, no canines, 3 premolars, and 3 molars—a total of 34 teeth. The canines, though constantly present, are the least conspicuous of the teeth and may be difficult to detect in an uncleaned skull. The incisors are small, spatulate, and decrease in size from the inner ones outward. The premolars are semilunar in general contour; the molars are double semilunar in effect, the last lower one having an additional cusp or loop at the posterior end. The lower molariform teeth are only about half the diameter of the upper ones.

SIGHT

The caribou's eyesight is not remarkable, but it cannot be said to be poor. Quickness in vision is no doubt somewhat dependent on the disposition of the animal. Does, which at certain seasons at least are more alert and suspicious than old bucks, appear to sight an enemy more readily than do the bucks. When they have seen a strange object, however, they seem unable to understand, in many cases, just what it is and will stand and stare at it, or circle about it to get its scent.

SCENT

The caribou's sense of smell is perhaps its greatest gift, for on this it relies for warning of danger. Many times the writer has stood in plain view, with caribou standing around watching him, drawing

nearer for a closer view, retreating in a sudden flurry of panic, then advancing again, gradually edging around to get the observer's scent. Sometimes caribou are persistent in their efforts to get the scent before they leave. This persistence is well illustrated in the following excerpt from the author's field notes:

I was crossing an open hillside when a doe appeared over the rise ahead of me, less than 100 yards away. We both stopped where we were, staring at each other. After a little she walked toward me a few paces and stared again. I grunted like a calf, but she paid no attention to that. Then she started slowly down the hill. There was a cross wind, and she was making a detour to get my scent. To prevent this, I too moved down hill, slowly, so as not to alarm her. She persisted. So did I, and we maneuvered thus until I found myself getting farther down hill than I cared to go. So I stopped and allowed her to have her way. She walked slowly, with muzzle extended, gradually coming around to my lee. Suddenly she drew back as if her nose had touched a hot iron. Again she reached out, testing the air current coming from me. Again she gave a perceptible start and this time started off on a slow run. She was not much frightened, however, for she stopped to look back several times. Since she was going my way I followed her, and in that manner, generally 200 yards apart, we traveled nearly a mile.

On many occasions caribou, after exhibiting only a momentary panic upon getting the observer's scent, have soon quieted down, but on the other hand on numerous occasions they have fled in terror at the first scent of man. Perhaps their reaction to such stimuli is dependent on their recent experiences; animals that have been pursued will no doubt be wary for some time afterward.

HEARING

Apparently the caribou is not accustomed to apprehend danger in sounds. The writer has shouted at caribou traveling by, with the result that they merely turned their heads for a moment, then continued on their way. It was only after repeated shouting that the animals finally broke into a run. However, one certainly cannot consider the caribou entirely indifferent to sound, for there are many exceptions. A. Radclyffe Dugmore, for instance, records (1913, facing p. 78) that a herd was frightened when the sound of his camera shutter revealed his presence and, he writes, "the badly frightened animals rushed about in every direction, some passing within arm's length of me." The present writer also has seen caribou quite alert to sound and on many occasions has observed them fleeing in terror at a rifle shot, though on many occasions a rifle shot has failed to disturb them greatly. It may safely be said that the caribou does not depend greatly on hearing and has some tendency to disregard sounds, at least as a source of danger (p. 29).

GENERAL HABITS AND TEMPERAMENT

BEHAVIOR IN DANGER

The caribou is a highly gregarious animal and, in marked contrast to the solitary and alert moose, for instance, is rather easily approached and appears somewhat stupid. This is no doubt due to the fact that among animals in a herd there is a natural tendency for each one to depend on the others to some extent for detecting danger. The individual animals become so accustomed to hearing

sounds made by others nearby that as a rule they pay little attention to the snapping of twigs or to other noises made by a hunter.

One day the writer, starting up a slope through the spruce forest, met a group of caribou traveling in the opposite direction. He stood still, and the animals continued on their way unaware and were passing at close range when he walked quickly toward the nearest buck and, although in plain sight and making considerable noise, approached within about 50 feet of the animal before being detected.

Another incident illustrates the caribou's indifference to sounds made by other members of a group. On September 17, 1920, a warm still day in the midst of the migration period, the writer crept within a few yards of a small group of caribou resting in a fringe of bushes just above timber. The tips of a large pair of antlers were visible over the willow tops. At one side lay a doe and young buck, lazily chewing the cud. Presently their heads dropped, sinking lower and lower, until they caught up with a jerk. After nodding sleepily in this manner for some time, the buck laid his head flat on the ground and apparently went sound asleep. A large buck came down the slope toward the drowsy group, stopped on a little rise to look them over for a moment, and then joined them.

Soon afterward another buck came from the same direction—a splendid animal, with dark body and shiny white neck, feet clicking as he walked. Meanwhile the young buck and the doe had not even turned their heads to look when the newcomers arrived. The last big buck busied himself for a while threshing a small spruce clump with his antlers, then yawned and walked over to the big buck whose antlers could be seen over the bushes, and began prodding him until he arose. The two made a few passes at each other with their antlers, yawned, and then began nosing about on the ground. A number of does, hitherto out of sight, arose, and several young animals approached, two young bucks clashing their antlers frequently. A young buck and a doe clashed antlers playfully, until the doe ran aside. With all this disturbance most of the animals were soon on their feet, and the writer made several photographic exposures before they were gone (pl. 3, *B*). It was clear that the animals paid little attention to each other. In fact they seemed very unsuspecting, and one went to sleep.

During these investigations caribou were frequently found sleeping. On a pleasant evening in September three bucks were observed lying on a high open slope. One of them had lost an antler, and as his head drooped sleepily the lone antler weighed down on one side, but whenever he raised his head he held it poised evenly. Once he lay for some time flat on the ground, head resting on its side, like a dog, apparently giving in to sleep without reserve. His two companions nodded sleepily for a time, but finally raised their heads in a more wakeful attitude and began chewing the cud. Eventually the one-horned buck arose, stretched his legs deliberately, then wandered along slowly, soon followed by the other two.

An interesting caribou hunting incident was related to the writer by a prospector, whose companion, carrying an ax, came upon seven

bucks, sleeping. At his approach, 6 jumped up and ran away, but 1 remained asleep. The man walked up to the animal and for a moment considered knocking it in the head with his ax, but fearing that he might only wound it and become entangled with it in its struggles, he backed away and threw a rock toward it, at which the animal awoke and fled.

Another instance was told by a hunter who found a caribou doe sleeping on a gravel bar of Delta River: He walked up close with his camera and took a photograph (pl. 6, A). Then, putting away his camera and acting on an impulse, he went up to the animal and seized her. A wild struggle ensued, but eventually the caribou was secured with ropes, and with the help of others was brought to a barn at Rapids Roadhouse, nearby, where she was kept for a while, then turned loose.

It is unusual for a wild animal to be so sound asleep that one can walk up to it and actually seize it, yet still another instance observed illustrates the caribou's exceptional tendency in this regard. Traveling with two others along the edge of a lava bed on Unimak Island, on May 8, 1925, the writer spied a yearling caribou a little to one side. As it appeared to be sound asleep, curled up like a resting dog, two of the men walked to within a few feet of it, preparing to capture it. The animal awoke, stared in bewilderment for a moment, then bounded away. It was a little awkward in its gait at first, giving the impression that it was injured or diseased, but it soon limbered up. Probably the animal had been lying there long enough to become somewhat stiffened.

In general, does are more alert and more active than old bucks; hence, a traveling band is generally headed by a doe, or a young buck. Whenever a band appeared suddenly during the writer's investigation, it was generally the silhouetted form of a doe that was first seen topping a rise. When a band is fleeing from danger, the big monarchs of the herd are likely to lag behind, even a fawn sometimes keeping the lead for a short distance. The big bucks become very fat in summer and early fall, and when flight is necessary they are outdistanced by other members of the herd. Furthermore, besides being more deliberate in movement and less nimble than the does and the young, they are often less apprehensive of danger.

The behavior of caribou in the presence of danger is further illustrated by the following incident: A doe in the lead of a band of caribou topping a rise stopped upon observing the writer standing in the open. The others crowded up, uncertain what the danger was. When the lead doe turned her head a moment, the writer managed to slip behind a rock, worked out of sight down the hill, and by a detour came up at one side of the group, still standing in uncertainty, looking for the object that had stopped the lead doe. Some became uneasy with the suspense. A doe, seized with panic, dashed wildly over the back trail but soon returned to her companions, before she had any big following. There were a few false starts, alternating with a nervous survey in all directions by the huddled group. Then one started down hill, more followed, and in a few moments the whole band, having given way to its fears, was dashing down the slope toward the timbered valley.



B5480M; B32429

A, Caribou doe, fast asleep, later captured before it awoke (photo by Frank Glaser). *B*, The caribou is an excellent swimmer.



B29866; B29864

A, Lichens palatable to caribou—*Cladonia alpestris* growing above *C. amaurocraea celata*. B, *C. s. sylvatica*, a favorite lichen of the caribou.

Another time the writer, walking on an open ridge, sighted a band of caribou approaching at a little distance but disappearing momentarily in a little dip in the ridge. The camera was at hand; but there was no cover, and the caribou would come over the nearest knoll in a few moments. Rushing down the slope to a stunted spruce the writer thrust a limb down inside his coat collar at the back of the neck, stuck a limb in each breast pocket, hurried back to the ridge top, and had just squatted in their path when the caribou appeared in view. As they filed by, at a distance of 75 feet, some glanced a little suspiciously and others paid no attention while two photographic exposures were made. Last of all came an old buck. The moment he came in sight he gave a start and stared, but as the writer remained motionless, his suspicions were allayed and he went on with quickened pace.

Caribou frequently show a headstrong determination in emergency, brought out in a manner sometimes recalling similar habits of the prong-horned antelope. Once while traveling with dog team over an undulating niggerhead flat, the writer coming over a rise frightened a band of caribou, and the animals sped away on a course somewhat parallel with that of the team. The dogs raced at full speed along the trail, eager to head off the caribou, which seemed equally determined to cross the trail ahead. After a while, however, veering a little, the band got out of the way, and the dogs could once more be managed.

Panic in a herd was observed during attempts to capture wild caribou for domestication experiments, undertaken by an operator on Chena River. One morning when a herd came along a lead fence headed for the corral, the writer stood alone not far from the open gate, waiting for the animals to pass. The lead doe, full of suspicion, stopped squarely in the gate opening, and others crowded around her. Presently she started back down the hill. This was the crucial moment. The writer dashed out, shouting, hoping to frighten the animals back into the corral, but so strong was their determination that most of them, escaping down the hill, ran by at very close range, some so near that the writer felt a little uncomfortable. This and similar experiences indicate convincingly that often when caribou are alarmed they have a tendency to flee in the direction from which they came.

During the excitement at this corral a doe and a young buck became overheated and somewhat trampled by the others, and were unable to go far. This was in September. They died a few days later, although water and food were taken to them each day. Of 4 fawns captured, 1 escaped, 2 died within 48 hours, and the fourth recovered and became tame. The animals had been running about wildly trying to escape from the corral, leaping at the bars.

At another time the writer during a period of unusually hot weather in August caught a fine vigorous buck, together with a doe and a fawn. The two latter were easily roped and subdued, but they suffered so much from overexertion that they were released after a day or two, in the hope that they might recover when given their freedom. The buck had been subdued only after a considerable struggle, and as he was quite pugnacious he was dehorned. He was

left overnight in the corral, with a rope trailing from a halter. Next morning he was dead.

These instances show that when cornered or close pressed the caribou become wild with terror. If free to escape, they gallop madly at breakneck speed over rocks or any ground that intervenes. And their exhaustion is sometimes extreme.

CURIOSITY

Curiosity is a strong trait in the caribou. The writer has had a young buck approach on the run until near enough for its eyes to be seen in some detail. One day in July, on the Alaska Peninsula, a buck was spied lying on the flat grassland bordering a lagoon. As there was no cover of any kind for stalking, the writer in plain view walked slowly toward the animal. Presently, sensing danger, the animal got to its feet. The writer continued moving leisurely, but in a stooping posture, swinging his hands before him as though traveling on all fours and taking care to keep his direction of travel in a line that would pass a little to one side of the animal. The buck watched curiously, began to feed a little, but stopped again to watch the figure hunching along. Whenever it became a little restless the writer veered away for a time, until the buck was reassured. In this manner it was possible to get within long rifle shot, before the animal escaped.

COMMUNICATION

Generally the only sound emitted by the caribou is a low coughlike grunt usually given by a fawn or its mother. The surviving fawn whose capture was described on page 31 became tame in less than 10 days and became so attached to the owner that it hardly let him out of its sight. When the owner, working about the pasture fence, sometimes disappeared from view behind bushes or trees, the little caribou would run about with continued grunting until the "foster parent" reappeared. In the wild this call apparently is used principally on similar occasions, between does and their young.

Several times the writer has heard caribou emit a grunting sound shorter, lower, and more guttural than this call, never heard plainly but reminding him of the low grunts given by captive bison. Once this was done by a young buck, walking away after being disturbed. Another time the sounds came from a traveling band of caribou, and it seemed, but not certainly, that they were produced by the males.

No doubt caribou ordinarily communicate by actions and attitudes. No gestures can be described as intended to convey an idea, but the normal actions of an animal in the pursuance of its own intentions are keenly interpreted by others, and there is thus little need for "conversation." If one sights danger, its attitude is likely to warn the others and they too will be on guard, seeking the cause of alarm. If one animal approaches another, some mannerism tells the other whether it is with hostile, friendly, or neutral intent—whether for a friendly bout with antlers in the case of young bucks, a wrangle over a choice bed in the snow, or nothing in particular.

The white rump patch may serve as a signal for recognition, although probably used unconsciously. When taking flight, the

animal holds the tail vertically and the patch of white about its base is more fully revealed. This feature is not, however, so fully specialized as in the white-tailed deer or the prong-horned antelope.

An experience on Chena River indicates the possibility that the white rump patch is actually useful for recognition. Returning to camp through the woods, after dark, and relying on the familiar contour of the skyline for guidance, the writer was having great difficulty in avoiding bushes and trees. Suddenly after a loud crash in the brush ahead, there was a faint gleam of white—the rump patch of a caribou. The animal did not go far, but upon being approached it again made a short rush, though evidently it was not inclined to go far in the darkness. All that could be made out, aside from a vague shadowy impression, was the faintly gleaming white rump.

GAIT

In walking, the caribou somewhat resembles other deer, but its gait, of course, has attitudes and peculiarities characteristic of caribou. In many cases the hind foot registers exactly in the track of the front foot; at other times it covers half of it; or it may form a distinct track behind that of the front foot. The neck is held nearly horizontal, the head even with or below the line of the back, with muzzle depressed. Especially noticeable is the clicking sound produced by the tendons of the foot.

When in a hurry the caribou breaks into an easy trot, a gait accompanied by an attitude and little mannerisms characteristic of this animal, presenting a picture somewhat difficult to put into words. There is a buoyant swing, with elastic, vigorous recovery of the muscles; the hind feet swing high and wide at every step, and the head, which in walking is held at a slight angle toward the ground, is raised high and held horizontal. This is the gait for long-distance running.

When alarmed at close range the caribou breaks into a gallop much like that of a horse. This gait is exhausting, and not long continued. In fall particularly, a fast run soon winds a caribou, especially big bucks in fat condition. The writer has seen old bucks, after hurrying up a hill, badly winded, mouth open, and tongue lolling. In fact, caribou may become so frightened and exhausted that their condition is serious. This is particularly true when an animal is captured in an enclosure (p. 31).

An interesting little habit was noticed on many occasions among frightened caribou that had sighted human beings. Convinced of the danger and about to flee, the animal would rise on its hind legs in a preliminary bound, somewhat similar to the "spy hop" of the jack rabbit, sometimes pivot part way around, and then speed away at the usual gallop. Usually it was an old buck that did this, but on some occasions a doe made this initial leap in her flight.

JUMPING ABILITY

One seldom has an opportunity to observe the jumping ability of a caribou. One incident during these investigations, however, at a time when caribou were held in a trapping corral, served to indicate to some extent their jumping power. The enclosing fence was

built of rails lashed to posts by wire. The animals had been left in the enclosure overnight, but the next morning it was found that all but about a dozen out of 50 had escaped by jumping over the fence, and the last of the big fat bucks was seen going over. The top rail, where the animals had crossed, was 52 inches from the ground. This is probably about as high as the caribou can jump, for there was an abundance of hair on the rail where the animals had crossed, and a few were still in the corral. Of those that had escaped there had been old, white-necked bucks, as well as does and younger animals of various ages.

SWIMMING

The caribou is an excellent swimmer, floating high in the water (pl. 6, *B*), but in Alaska practically the only opportunity for swimming occurs when the migrating herds encounter the Yukon, Tanana, and a few other streams, or lakes.

BREEDING HABITS

After quietly feeding, fattening, and growing antlers (p. 17) during summer, the caribou buck by September has accumulated the maximum quantity of fat, which lies on the back, sometimes 2 or 3 inches thick. Ever since spring the animal has been growing fat in preparation for the exhausting activity of the rutting season. The greatest thickness lies over the rump, near the base of the tail, and the entire layer is roughly wedge-shaped, tapering anteriorly until it disappears as a thin sheet near the shoulders. Considerable fat appears also in the abdominal cavity—in the omentum, about the kidneys, as in other animals—but the back fat is especially well developed in the caribou.

Another development in old bucks at this time is the great enlargement of the neck, which becomes greatly swollen, far beyond its usual size. Does also become fat at this season, but not to the same extent as the old bucks. Young males are in about the same condition as the does, without the enlargement of the neck, and fawns have very little fat.

There used to be a rule among old-time market hunters that an old buck is likely to be "strong" and unfit for food at any time after September 20, a sure indication of the near approach of the rut. Soon after that date old bucks begin to fight.

The writer has never witnessed a serious battle between caribou and has not received much first-hand information. It is clear, however, that hard fighting does take place, since locked antlers have often been found, indicating a form of tragedy that is common also among deer and moose. On one occasion the writer watched a group of caribou, including one or two old bucks and three younger males with superabundant energy. Frequently two of the younger bucks indulged in a sparring match, and sometimes all three were poking at each other, heads together, in a three-sided contest. It was clear that they were not in earnest, but were only giving vent to playful exuberance. An old buck nearby paid not the slightest heed to them, except that when one came too near, the old fellow would "shoo" the youngster away, with a threatening gesture.

In October the rut is on in earnest. The big bucks then herd up the does and run about ceaselessly, much of the time neglecting to eat. They begin to lose flesh, and by the time the rutting season is over, about the last of October, the reserve fat is gone and the animals have spent their energy for the season. Winter is begun in poor flesh. Thus the great development of fat in autumn is not for winter protection but is consumed during the mating season and apparently is provided for that purpose. It is significant that young animals that do not breed, but have to face the winter in company with their elders, do not develop excessive fat.

There is difference of opinion as to whether the old, fighting bucks or the younger males are the chief breeders. Some observers in Alaska have maintained that while the old herd leaders are fighting, keeping the does rounded up, many of the does are served by younger bucks. Observations made during the present investigation are inconclusive on this point. Judging, however, from the appearance of old bucks during the rut, their swollen necks, fat accumulations, and other special developments at that time, one is led to the conclusion that they render most of the service.

Throughout winter caribou remain poor in flesh, but early in spring some of them begin to pick up, and does in fair condition were observed in February. In April and early in May barren does are likely to be in good flesh and are sought by hunters for meat. Does with fawns, however, are still in poor condition. Indeed, it is not until July that any considerable numbers have begun definitely to accumulate fat. Very fat bucks are generally not met with until August, when they are once more laying up stores to carry them through the rutting season.

Sometime during winter the does and bucks become segregated. A spring migration observed at Tanana Crossing (p. 72), for instance, consisted almost entirely of does with fawn. In spring, as the fawning time approaches, it appears that the yearlings are cast adrift to shift for themselves. Thus on May 24, 1922, the writer found a band of eight yearlings by themselves, in a locality where does were also seen with their fawns. Other bands consisted of older bucks.

FAWNS

Fawns of caribou are born from about May 15 to June 15, about a month later than the fawns of reindeer, which usually arrive between April 15 and May 15, though the writer has one record of a reindeer calf born on April 6.

The young caribou is precocious. Apparently, soon after the little animal has become dry after birth it is on its feet and able to follow its mother. On one occasion, on May 21, 1922, a doe with a fawn no more than 2 or 3 days old fled upon being approached, the little one on wobbly legs. Thinking that it might be possible to catch the young animal and obtain a photograph, the writer followed on the run, up hill, but was soon outdistanced. Though the fawn once got into a snowdrift, and capture again seemed imminent, the doe returned to her offspring and by her presence encouraged its efforts. Before it could be reached, the little one floundered through the snow, and both animals disappeared over the hilltop.

No data are available to show when the fawn first feeds on vegetation, but probably it begins very soon to eat other things to supplement its mother's milk. Nursing continues throughout the summer, no doubt in diminishing degree, but one doe killed on September 23 had milk in the udder and her fawn was for many hours reluctant to leave the place. One observer stated that he had seen fawns sucking in the latter part of August, without interference by the doe. He had also seen them attempt to suck about the middle of September, but at such times the doe would kick and turn on her offspring with her antlers. Probably the fawns are weaned by the time the rut is on, although more information is needed on this point.

FOOD HABITS

IMPORTANCE OF LICHENS

It has been customary to consider the food of the caribou as consisting more or less exclusively of lichens, or "reindeer moss." While lichens are an important item, they are not required throughout the year, nor are they indispensable if a proper substitute is available.

In the stomach contents examined, *Cladonia belliflora* and *C. sylvatica* have been identified specifically, as well as *Cetraria cucullata* and *Thamnolia vermicularis*. Of the large group of lichens available, those of the genus *Cladonia* are best suited to the caribou's taste (pl. 7). Wherever caribou have been feeding persistently, *Cladonia* is the prevailing lichen. In the spring of 1922 bands of caribou were feeding in the hills at the head of Jarvis Creek, in the Delta River region, where extensive snow banks still lingered. *Cladonia* was the chief lichen type present. Below the front of the range lay a wide, open flat, bearing a rich growth of lichens, chiefly *Cetraria*, probably *C. cucullata*. Although a few caribou were observed here, the forage was essentially untouched, while on the nearby higher slopes *Cladonia* clearly showed that it was grazed.

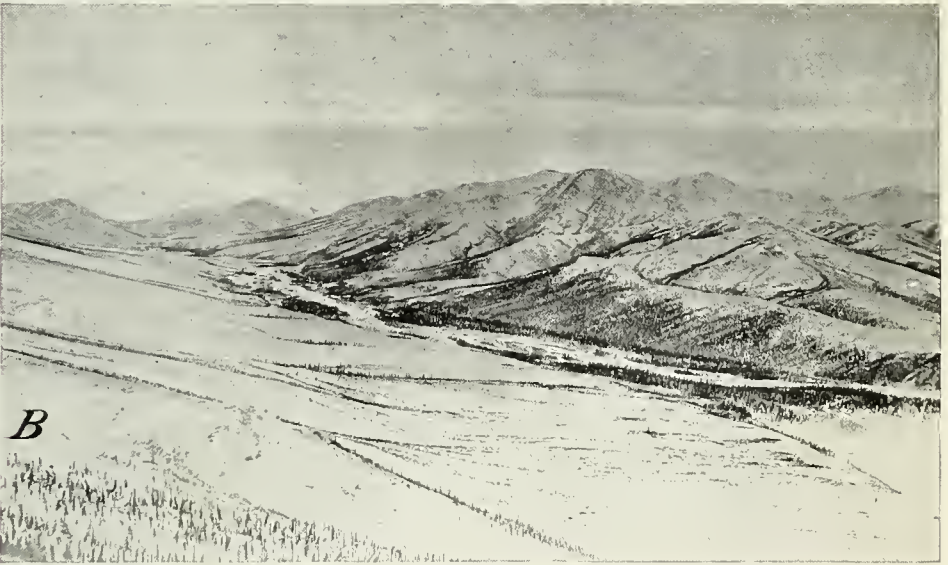
The caribou's craving for lichens is well known and has been illustrated in various ways. Even in summer when seeking other food, a caribou will stop and eagerly feed on any lichen patch encountered and is loath to leave.

Those who have had experience shipping reindeer from Europe have found it desirable to provide lichens, at least during transit. In captivity it is difficult to wean a caribou from the lichen diet, and to do so it becomes necessary for a time to deny it other food.

In the summer of 1923 the writer had excellent opportunity for several weeks to observe the food preferences of a captive buck. The animal was kept on a halter with a 50-foot rope, tethered to a heavy pole. A supply of lichens had been gathered in sacks, and when the summer food had withered to some extent the lichens were fed. The eagerness with which this buck came running when a supply of this food was in sight reminded one of the actions of a horse offered oats.

YEAR-ROUND FOOD

To supplement evidence obtained from field observations, stomach contents from a number of caribou, representing various seasons of the year, were preserved and later examined by F. P. Metcalf and Charles C. Sperry, of the Biological Survey's Food Habits Research



B21044; B20941

A, Caribou winter range on Yukon-Tanana upland. *B*, Winter range in Mount McKinley National Park.



B21756; B24350

A, Caribou on winter range. *B*, Reindeer doe eating a shed antler.

unit. The results, shown in table 3, indicate that grasses and lichens constitute the principal items in the caribou's bill of fare, followed by mosses, willows, *Betula rotundifolia*, *Vaccinium vitis-idaea* in smaller proportion, and a number of other plants in very small quantities, although most of these are persistently eaten.

Statistics of the kind shown in table 3, when based on relatively few stomach examinations, may be misleading if considered independently of field observations. It is particularly true in this case, for from 9 to 40 percent of the stomach contents, varying with the specimens, consisted of material that could not be identified. In order to make clear the necessity of correlating these figures with conditions in the field, certain facts should be noted. Stomachs collected in September held a high percentage of lichens—40½ percent. These animals were killed during migration at the head of Chena River, in a region rich in lichens, and in particular localities where this food was available. On the other hand, on Unimak Island, where some of the animals were killed, lichens are not available except in small quantities and were represented in stomachs by 0 to 8 percent of the contents. In other words, because the available food supply for the animal in the locality in which it happens to be feeding affects the percentage of the various items, the contents of a limited number of stomachs will not always show the animal's preference. In the case of the grass listed, an important item, it should be noted that there is a difference in palatability in summer and winter.

To present more clearly the caribou's food habits, it will be best to follow it through the seasons, noting its choice as the several plants become available.

WINTER FOOD

Winter is the lean season for caribou, as for other ungulates. At that season there is little variety, and the food is more or less covered with snow (pls. 8 and 9, A). Examination of stomach contents indicates that grasses are then eaten in large quantities, but lichens are important.

Winter feeding grounds are sought in fall after the heavy frosts have begun to kill the green vegetation. In Mount McKinley National Park, where the summer food—the green grasses—occurs most plentifully on the high slopes and the lichens are more plentiful in the lower hills, the change of diet was made, in some instances at least, with the first early snowfall. The caribou forsook the highlands early in September in 1922 and 1923, when the snow came. In 1922 snow fell on August 29. In each case this early snow, which was confined to the mountains, later disappeared, but many of the caribou had gone to the lower hills, although a few stragglers were still found in the high mountains. Early in August the vegetation began to turn yellow. A willow limb here and there, a few clumps of *Arctous alpina*, or blueberry bushes, showed yellow and red. Later in the month, and early in September, pure green vegetation was apparent only in swampy spots, recesses of the hillsides where seepage was working out toward the main stream. Such green "oases" are utilized to the last by the caribou that linger in the higher valleys.

TABLE 3.—Plants eaten by caribou, as shown by contents of 24 stomachs

Plant	February			April			July-August			September			Year-round food ¹	
	Stomachs in which found	Contents re- sented		Stomachs in which found	Contents re- sented		Stomachs in which found	Contents re- sented		Stomachs in which found	Contents re- sented		Stomachs in which found	Contents re- sented, average
		Maximum	Average		Maximum	Average		Maximum	Average		Maximum	Average		
Grasses and sedges	Number 4	Percent 35 $\frac{3}{4}$		Number 4	Percent 37 $\frac{1}{2}$		Number 4	Percent 61 $\frac{1}{2}$		Number 9	Percent 18 $\frac{1}{2}$		Number 24	Percent 30
Lichens	4	18 $\frac{3}{4}$		4	4 $\frac{1}{2}$		6	15		9	40 $\frac{1}{2}$		3 24	24
Mosses	4	20	12 $\frac{1}{2}$	4	80	13 $\frac{3}{4}$	4	5	3 $\frac{1}{2}$	9	10	7 $\frac{1}{4}$	4 24	8
Salix sp.	4	10	5	4	80	33 $\frac{1}{8}$	6	80	41 $\frac{1}{8}$	7	5	41 $\frac{1}{8}$	8 23	9
<i>Betula rotundifolia</i>	1	1		3	2	1	4	50	28 $\frac{3}{4}$	8	10	4 $\frac{1}{4}$	18	6
<i>Vaccinium vitis-idaea</i>	4	3	2 $\frac{1}{2}$	4	15	6 $\frac{1}{4}$	5	1		9	10	4	22	3
<i>V. uliginosum</i>										2	2	1+	4	(6)
<i>V. orizococcus</i>										1	1	1	4	(6)
<i>Ledum decumbens</i>	3	1	1	4	2	1	4	1	1	1	1	1	19	1
<i>Arcostaphylos uva-ursi</i>	1	1	1	1			1	1		1	3	1 $\frac{1}{2}$	3	2
<i>Arcodon alpina</i>													2	(6)
<i>Empetrum nigrum</i>										2	1	1-	2	(6)
<i>Cassiope</i> sp.	1	1	1	1	(?)	(?)	1	1	1	1	1	1	2	(6)
<i>C. mertensiana</i>													2	(6)
<i>C. lycopodioides</i>													2	(6)
<i>Picea</i> (2 sp.)	4	3	1 $\frac{3}{4}$	4	2	1	2	10	5	7	2	1	8 23	1
<i>Alnus</i> sp.										1	(?)	(?)	1	(6)
<i>Lycopodium</i> sp.										1	(?)	(?)	1	(6)
<i>Equisetum</i> sp.										1			1	(6)
<i>Populus balsamifera</i>										1	1	1	1	(6)
<i>Phalloidoe empetriorum</i>										1	(?)	(?)	1	(6)
<i>Diapensia lapponica</i>				1	(?)	(?)	1	1	(?)	1	1	1	2	(6)
<i>Dryas octopetala</i>				2	(?)	(?)	2	2	(?)	2	1	1	4	(6)
<i>Polygonaceo.</i>				4	(?)	2 $\frac{1}{2}$	1	5	(?)	2	1	1-	11	(6)
<i>Harrimanella stellariana</i>				1	(?)	(?)	1	(?)	(?)	1	1	1	1	(6)
<i>Chamaecistus procumbens</i>	1	1	1	1	1	1	1	1	1	3	1	1	5	(6)
<i>Andromeda</i>				1	(?)	(?)	1	1	1	1	1	1	1	(6)
Fungus (road stool)				1	(?)	(?)	1	1	1	1	1	1	1	(6)
Fabaceae													1	(6)
<i>Triglochin</i>													1	(6)
<i>Pyrola</i> sp.													1	(6)
<i>P. grandiflora</i>													1	(6)

¹ Includes stomachs not represented in preceding columns.
² *Hieracium odorata*, 2; *Bromus* sp., 1; *Danthonia spicata*, 1.
³ *Cladonia* sp., 22; *C. belliflora*, 1; *C. sylvatica*, 1; *Citrania cucullata*, 1; *Thamnomia termitularis*, 2.
⁴ *Hypnum* sp., 10; *H. schreberi*, 6; *Dicranum*, sp., 19; *D. groenlandicum*, 1; *D. nivalicum*, 2; *D. scoparium*, 1; *Polytrichum* sp., 20; *P. alpinum*, 1; *P. commune*, 3; *P. strictum*, 3; *Hylloconium profliferum*, 12.
⁵ *Salix* sp., 23; *S. phlebophylla*, 1.
⁶ Grouped as "miscellaneous", totaling 17 percent.
⁷ Trace.
⁸ *Picea canadensis*, 13; *P. mariana*, 10.

In fall, before the heavy snows, there is still some variety. In addition to the lichens, and the grasses, which constitute the bulk of the food, willow leaves are eaten to some extent, as well as the leaves of dwarf birch, and various other plants that are still attractive to the animals. After the rutting season, when the deep snow covers the ground, the caribou seem more inclined to remain in a definite area. Midwinter is probably the season of least wandering for these restless animals. On Post River, in the Rainy Pass region, which was visited in February 1922, the writer found a herd living contentedly in a small range of rounded hills, apparently permanent winter range. The animals had dug deep pits in the snow to reach the lichens, bits of which lay scattered in the vicinity of these excavations. The snow on these feeding grounds was packed hard by the trampling of many caribou.

In other localities certain spots are known to be favorite winter feeding grounds for caribou. There is such a spot in Mount McKinley Park, adjacent to Stony, Clearwater, and Moonlight Creeks, and local residents no doubt can name many such areas that are especially attractive to the caribou. On the headwaters of Chatanika River, the hills at the head of Nome Creek are a favorite resort. All through the areas occupied by caribou are special localities that are persistently sought by these animals. A characteristic feature of such spots is, of course, the presence of lichens.

In some parts of Alaska excessive snowfall is a barrier to caribou distribution in winter. On the south slopes of the Alaska Range the snowfall is so heavy that both caribou and mountain sheep usually must retreat to the north slopes, where the precipitation is much less. Another factor is wind. Slopes that are swept nearly bare of snow furnish readily available food. Such conditions prevail in many parts of the north slope of the Alaska Range, in the Brooks Range, and in other parts of interior Alaska. The caribou do not hesitate to descend to the spruce woods, however, and paw through considerable snow after the lichens. And there is a certain amount of wandering from one mountain to another, across a valley, or along the ridges, some indulgence in the wanderlust so characteristic of this animal.

In some cases lichens are not available, summer or winter, and it may be puzzling to determine how the animals overcome such a difficulty. According to Robert Brown (1868, p. 355) the caribou's food in Greenland—

consists chiefly of various species of *Empetrum*, *Vaccinium*, *Betula*, etc.; and I can hardly think that the traditional "reindeer moss" (*Cladonia* of various species) forms any great portion of its subsistence, as that lichen is nowhere found in Greenland in such quantities as to afford food for any animal.

A similar condition obtains on the greater part of Alaska Peninsula and Unimak Island. W. R. Smith, of the United States Geological Survey, informed the writer that on the peninsula he had found lichens only in the rolling country northeast of Becharof Lake. At the western end of the peninsula and on Unimak Island the writer found no lichens in appreciable quantity, and in this region such food could not be depended on by the caribou. Brown's statement of conditions in Greenland, however, as well as the writer's personal observations in Alaska, show that the caribou do find substitutes for lichens.

A study of certain areas on Unimak Island, above the tide flats, on land which might be classed as typical tundra, brought out the fact that the vegetation was composed largely of four types, as follows: *Empetrum nigrum*, 40 percent; true mosses, 30 percent; grasses, 10 percent; and *Arctostaphylos uva-ursi*, 6 percent. Where lichens are absent, but caribou present, these plants are unusually plentiful. Examination of stomach contents (table 4) shows that this is the winter food, and observations made during this investigation confirm these statistics. Late in April and early in May, when these observations were made, essentially winter conditions still prevailed as far as vegetation was concerned. Practically the only new vegetation consisted of low green bunchy growths just appearing, *Coelopleurum gmelini* and *Heracleum lanatum*, one or both of which were being eaten by the caribou.

TABLE 4.—Stomach contents of caribou from Unimak Island, Alaska

Animal	Grass (including Poa)	<i>Empetrum nigrum</i>	<i>Arctostaphylos uva-ursi</i>	Lichens
	Percent	Percent	Percent	Percent
Male collected on Apr. 30, 1925 ¹	82	15	3	(2)
Do.....	5	(³)	⁴ 95	8
Blind yearling buck collected on May 9, 1925.....	60	28	4	

¹ Stomach contents included also 1 seed of *Coelopleurum gmelini*, a few leaves of *Polygonum*, and a trace of moss (*Aulaconium*).

² Trace.

³ Trace; a few leaves.

⁴ Leaves and stems.

On May 9 a blind yearling was found and watched for some time (pl. 4, A). The animal stumbled about awkwardly but had evidently managed to live a long time without sight. It could be approached within a few feet, close enough to observe the eyes clearly and see that portions of the iris protruded through the cornea. Occasionally the animal, hearing the approach, would dash off in a panic but each time it soon stopped because of difficulty in finding its footing.

To all appearances, this animal was grazing much as any other caribou would. It offered a striking illustration of the use of smell in finding food. On one occasion the animal had become suspicious of the writer's presence and started off on a short flight, but just as it was getting under way its nose passed over a small patch of *Arctostaphylos uva-ursi*. Immediately forgetting its fright, its nose swung to the ground as if by some compelling hand. Several similar clumps were found by scent. Later in the day the animal was taken as a specimen and to study the stomach contents, the diseased eyes, and the general condition. The stomach contents, given in table 4, show that the animal's food did not differ materially from that of normal individuals. Without doubt the sense of smell is so great an aid in locating lichens and other food under the snow as to indicate that probably the caribou normally feeds largely by scent.

It is interesting to note that substitutes for lichens in winter food are evergreen species. Both leaves and berries of *Empetrum nigrum*

and *Arctostaphylos uva-ursi* remain in fair condition throughout winter. Such, also, are *Cassiope* and certain species of *Vaccinium*, which, however, are only locally abundant.

SPRING FEEDING

During winter caribou generally become poor, and the old bucks sometimes have already become almost emaciated by the end of the autumn mating season. Late in winter some of the bucks may be in fair condition, as are the barren does, but the does with fawn, as well as many others of various ages, have become poor. When spring ushers in a new growth of vegetation, the animals seek a change of diet. About the first fresh growth available is in the interior of niggerhead clumps, species of *Eriophorum*, which in May or even earlier have begun to produce green stems within the shaggy clumps or "heads." Then, too, appear the gray, downy blossoms, which also are eaten. About the same time willow catkins become available, and one may see caribou hurrying from one willow clump to another, nipping off catkins or buds, if the latter are big enough. On one occasion, in May, the writer watched a caribou on Robertson River spend considerable time at a willow bush on an open sand bar. When the animal had finished and traveled on, the willow was examined and an alder was found growing with it, the limbs of the two shrubs intermingled. The caribou had neatly picked off the willow buds and catkins but had left the alder twigs untouched.

SUMMER AND FALL FEEDING

As spring advances and more plant growth appears, a greater variety of food becomes available, and when summer has come the diet of lichens is forsaken to a great extent. In June and July great herds sometimes sweep down into grassy lowlands in some localities, or to the grassy mountain slopes of the Alaska Range, as the case may be. In the mountain meadows they seek damp spots, where luscious grasses and other plants are found.

Caribou are fond of willow leaves and browse extensively. No doubt they eat many varieties of *Salix*, but it has been impossible to determine the range of their taste among these, although two species were found to be particularly acceptable—the large-leaved *S. alaxensis* and the smaller *S. pulchra*. Of these two the former seems to be preferred, judging by the actions of a captive caribou and by field observations. Another form of browse much sought is *Betula rotundifolia*, which is of almost universal distribution in the North. The writer once watched at close range a young buck feeding on dwarf birch in an open saddle, stripping the leaves from one twig after another as it walked along. The animal, as usual, was in a hurry and sometimes stepped away before finishing a bite to hurry on to another mouthful of leaves, like a commuter eating breakfast on the run. This mannerism may be noticed in less degree among other grazing ungulates, including a tendency to reach back for a tempting morsel that has almost been passed.

In July and August, when mushrooms become plentiful, these are promptly placed on the caribou menu. The writer at this time of

year shot one young buck the stomach of which was filled with mushrooms, almost to the exclusion of other food. On this occasion numerous fungi were found to have been bitten into by caribou.

To obtain a fairly comprehensive list of the plants eaten, one would need to examine a large series of caribou stomachs. A long list of herbaceous plants enters into the choice of summer food, particularly since the caribou is such an inveterate wanderer. The animal just mentioned as collected happened to be in a locality where mushrooms were abundant. Another killed on a high slope on the same trip had been feeding largely on lichens, even though it was summer, for caribou do not pass by this food when they find it. At another time dwarf birch may be the dominant growth available.

In June and July large herds (on one occasion estimated to number many thousands) descend into Mosquito Flats in the Kechumstuk district, where a luxuriant stand of grass, chiefly *Calamagrostis canadensis*, is the dominant growth in areas visited by the caribou. A homesteader who had been planning to cut a patch of this for hay was busy for 2 days keeping off the animals.

The caribou thus pass easily through summer in the midst of plenty, so that in August, and especially early in September, they are very fat. Then the frost begins to limit the food supply once more, and the next big event is the return of snow and winter.

An attempt was made to examine various "licks" visited by caribou, and analyses of samples of mud and water from such places were made. The data obtained, however, are too meager to be significant.

CONSUMPTION OF SHED ANTLERS AND VELVET

Observations in a herd of reindeer revealed a curious habit that may be shared to some extent by the caribou—eating shed antlers. Early in March 1922 the writer visited the Twitchell reindeer herd in the Beaver Mountains, Kuskokwim watershed. Many of the animals had shed their antlers and were seen eating them (pl. 9, *B*). The antler was worked back between the molars on one side and bits gnawed off. Frequently another animal would rush up and appropriate the piece of antler, until it, in turn, might be driven away. Evidently there was shortage of shed horns, for the reindeer were gnawing at those of their companions, still unshed, and apparently the does considered it a maternal privilege to nibble at the antler tips of their fawns. Most of the fawns had antlers much reduced, on some mere stumps remaining, and there were few adults that had not been "trimmed" to some degree by their neighbors. Sometimes, the writer was told, the reindeer begin nibbling at the antlers before the velvet is shed, causing them to bleed.

This practice suggests a possible fate of many shed antlers of caribou. In the wild state the animals are not so closely herded, and no indications were found that the caribou gnaw the antlers before they are shed. Human control may have developed to the extreme a practice that existed in the wild herds. Probably, however, lacking the freedom to wander where minerals might be had, the domestic herds were deficient in this respect and took to antler chewing to supply the need. Lovering records an observation on

Alaska Peninsula bearing on this habit (Scull, 1914). A caribou buck was busy scraping the velvet from its horns in the alders and ate it as it came loose. The animal was taken, and some of the velvet was found in its mouth.

OTHER FOOD HABITS

The writer has been told that in winter the caribou will nibble at muskrat houses and will smell out and eat food caches stored by mice. According to an Alaska herder, reindeer also eat mice when they can catch them. R. Collett (1876) says that the wild Norwegian reindeer are fond of lemmings, and Arnold Jacobi (1931) cites instances of mice and fish serving as caribou food.

THE MIGRATORY HABIT

The seasonal movements of caribou have caught the attention of man from the earliest times, and naturally an explanation of this most interesting habit has been sought. The migratory routes of the Alaska-Yukon herds are discussed on pages 56 to 73; in this connection the character of the animal's migrations and the explanations of these movements are considered.

THE CARIBOU IN MIGRATION

The principal feature of caribou migration appears to be its uncertainty. One season the animals may come through in great numbers, massed in good-sized bands, a striking procession, the chronicles of which reach the front pages of local newspapers. Another season their passing may be almost unnoticed, as they dribble through in such small bands as to leave the impression that there are few caribou in the country. In the fall of 1920 the migration was of the first type. Large herds were reported, and many exaggerated accounts were circulated, because of the impressiveness of such a movement. Although there was much exaggeration, many large herds were actually observed, however, and there can be no question that this was a remarkable migration.

The following year the migration attracted little attention. On the main route of travel, at the heads of Chena and Chatanika Rivers, the writer found only scattered individuals and small herds. It might be suggestive that in 1920 the migration passed close to Fairbanks and other localities where unusual opportunities for observation were offered. On the other hand, if the herds had traveled on a route remote from settlements or camps, fewer observers would have been present and a different impression would have obtained. In the fall of 1920, when the writer was stationed at the head of Chena River, a locality ordinarily on the main highway of caribou migration, only about 5,500 animals were observed. That same year the animals had massed in greater numbers over a route near Fairbanks, far to the west.

Thus it is easily seen that the erratic movements of the caribou make it difficult to know just where the herds are and how great a migration is taking place. It is probable that the caribou may become massed in larger herds in one season than in another, more or

less by chance. There may be an unusual influx of animals from adjacent territory, a combining of forces that tends to concentration. Many factors no doubt conspire to create the characteristic uncertainty of caribou movements. The Indians who depend on caribou migrations are familiar with this feature—to their sorrow, when the meat supply fails.

The movements of caribou during the annual migration also vary greatly. At one time they appear to be in a hurry and may break into a run for a short time. At others they move more leisurely, dally along with their feeding, and if the weather is pleasant they may lie a long time basking in the sun. This has been observed principally in September, before the rut. When large numbers are involved, the movement is likely to be steady and fairly slow, especially so in spring. The writer has personally observed very few of the large bands, and these have been seen in spring, such as the northward migration over the Alaska Range in the spring of 1921 (p. 72). As many as 500 were assembled at times during that run, but they appeared first on the summit in single file. One after another they slid down a precipitous snowy slope, creating a deep furrow which marked their route. On reaching the lower slopes they came along steadily, methodically, one after another. On reaching the base of the range many gathered in a large band and lingered for hours.

On April 24, 1923, Adolph Murie and the writer witnessed an extensive movement on the hills at the divide between Twelvemile Creek and McManus Creek, in the region between Fairbanks and Circle. Long single files of animals were winding through a little valley, up to a hilltop, across a saddle, and onward to another hill, which was so speckled with caribou as to present the appearance of a snowy slope covered with a scattered stand of stunted black spruce. The animals counted numbered 2,500, and it was estimated that there were in all about 3,000, for others were still coming from behind the mountains, all heading eastward toward Eagle Summit. Many more, of course, may have passed during the day. This is the greatest aggregation of caribou that the writer saw at any one time. In this case, also, the movement was slow and steady, with a tendency to concentrate in some numbers when a column was halted near its head.

In general it is likely that the caribou's local movements are determined by the food supply or by factors favoring ease of travel. It is natural for the animals to seek the comparatively level ridges when migrating. If a valley intervenes it offers no obstacles and some will cross it, depending on individual whim. On the other hand if a peak rises from the ridge the trail will swing around to one side and regain the ridge level beyond. Even in such cases, however, there may be exceptions, for if the peak of the dome is not too high a few trails will lead straight over it. A well-worn trail may be taken as an expression of the average of caribou behavior, in this respect, when on migration, and the best-marked trails are as a rule in the open country. An exception would, of course, prevail in instances when the whole migration veers off in an unusual direction where nearly the whole area is wooded. Caribou, for instance, do not hesitate to cross the Tanana Valley, but their objective in doing so is the high Alaska Range (p. 70).

EXPLANATION OF THE MIGRATORY HABIT⁷

THE NEED-FOR-SHELTER THEORY

A common explanation of the caribou's migratory habit is that the animals move south in winter for the shelter of the forest, returning northward in spring to spend the summer on the Arctic coast. This cannot apply to the Alaska-Yukon caribou. The great herds of the region perform extended and striking migrations each year, yet it can hardly be said that they travel all these hundreds of miles for shelter, since the summer and winter ranges are substantially alike. Those individuals that travel all the way from Rampart, on the Yukon, to the vicinity of Whitehorse, on the upper Yukon, could remain at Rampart and find the same kind of shelter that they find at Whitehorse, with practically the same climatic conditions. Furthermore, caribou do winter in practically all sections of their range.

Caribou living on the Arctic slope winter there in some numbers (at least they did during the period of their former abundance), yet no forest is present to afford shelter, and the winter range of these animals lies far north of the summer range of the neighboring herd to the south. Caribou on some of the Arctic islands and in Greenland remain there winter and summer; and, finally, not all the members of the central Canadian herd leave the Arctic coast in winter, for many observers have found them near the Arctic coast at that season. R. M. Anderson (1913) writes that large herds of caribou were seen on the east branch of the Coppermine River, opposite the mouth of Kendall River, in the latter part of February. Alfred H. Harrison (1908) relates that many were killed about upper Clarence, or Herschel Island, River late in the winter of 1906, and others were obtained on upper Kay Point River. E. P. Herendeen (1892), writing of Point Barrow, Alaska, states:

The great mid-winter hunt begins soon after the sun returns; or about the last of January. Then the Esquimaux go out on the plains which stretch far to the south and east, and are covered with snow for about 9 months of the year.

These northern herds could have moved to the south, if they required the shelter of the forests available to the more southern herd.

Observations made during this investigation, furthermore, do not indicate a great need of shelter on the part of caribou. The animals are warmly clad (even their noses are covered with hair), and they were repeatedly found on exposed ridges above timber line during severe winter weather. Possibly severe storms would cause them to seek shelter, but on many of the occasions when caribou were found in the spruce forests there was comparatively mild weather. A. J. Stone (1899), writing of the caribou of British Columbia, says that during heavy storms in winter the caribou are sometimes known to come into the edge of the timber, remaining there only during the storm, but almost all their food is taken from the high country, where they are found in midwinter. Edward J. House (1909, p. 306), writing of British Columbia, says that caribou inhabit

⁷ The effect of light and length of day, proposed as a factor in bird migration (Allard, 1928), and the ice-age theory, are not applicable to caribou and other deer and need not be here considered.

almost entirely "the open country on the tops of the northern mountains, and, according to the Indians, are only driven temporarily to the shelter of the timber by the most severe blizzards during the winter."

The migrating habit appears to be common to the genus to which the caribou belong (with possibly a few minor exceptions). Considering the great hardihood of this Arctic animal and the facts of its distribution and movements, one cannot consider the need for shelter as sufficient to account for the great migrations.

THE FLY-PEST THEORY

Another factor sometimes considered in the movements of large mammals is the fly pest. It might be reasoned that the great swarms of mosquitoes so common in the far North would tend to drive the caribou to more favorable localities during the summer season. No doubt mosquitoes torture the animals and may influence their actions to some extent (p. 11), but such movements would no doubt be local. This factor would assuredly not apply to some of the largest Alaska-Yukon herds—where the summer and winter ranges are so much alike; where the animals frequent the high country, normally, both winter and summer; and where their close neighbor, the moose, must also endure the mosquitoes, yet has not developed an elaborate migration. Furthermore, the spring migrations take place before the insect pests have appeared and the greatest migration in autumn occurs after the "fly season."

RESPONSE TO HORMONE SECRETION

A. R. Cahn has offered some interesting suggestions on the causes of animal migration, which merit careful consideration. He states (1925, p. 543) that ". . . the animal body is a complex of regulatory mechanisms which regulate the body activities of the animal and, through these, may regulate the distribution of the species." And again (p. 544):

Thus an animal regulates through behavior by the following steps: (1) Certain processes are going on within the animal; (2) external changes affect the rate of these processes and upset them; (3) the result is movement of the animal in an attempt to adjust to the changes; (4) these movements bring the animal into various conditions, one of which may relieve the disturbance, in which case the disturbing factor being removed, movement would cease, as the equilibrium between processes and environment is established. By these steps we see that the environment of an animal may be regulated by behaviour, e. g., movement.

Cahn then supposes the disturbing change to be internal instead of external and concludes that the result would be the same. He believes, further, that reproductive activities coincide with migration periods. As he states it (1925, p. 555), "Thus migration becomes an adaptive response to gonactivity, and since this activity is a hormone secretion, migration becomes an *effect* to a hormone *cause*."

In some cases, however, the breeding activity of mammals in the deer group does not coincide exactly with the migration period. The caribou of interior Alaska begin their definite migratory movement in some sections as early as the latter part of July. It is

conceivable that hormone secretions may become effective in advance of the actual breeding time, but a caribou movement in July, or even early in August, would certainly appear to be uninfluenced by "gonactivity" in view of the facts that the old bucks do not even shed the velvet until about September 1, and the does shed later; that the actual physiological changes resulting in the characteristic odor of old breeding bucks do not appear until after the middle of September; and finally, that much of the breeding takes place in October.

The elk of Jackson Hole, Wyo., show a restlessness in August almost coinciding with the shedding of velvet, but the movement is a shifting about, and as a matter of fact the entire breeding activities take place on the summer range. Rather early in fall there is a slight drift of elk toward the winter range, but breeding is over when the big migration takes place, depending on the time of heavy snowfall on the summer range.

The mule deer of the mountains of the northern Jackson Hole region migrate eastward, in a direction opposite to that of the upper Yellowstone elk. These deer leave the mountains in the vicinity of Two Ocean Pass, descend to the upper Yellowstone Valley, and then climb the Absaroka Divide, reaching their winter range on the lowlands beyond. If the deer are seeking physiological adjustment with the environment, why do they not stop in the Yellowstone Valley, and why do they cross a range much higher than the area of their summer range? It is significant that heavy snow makes the upper Yellowstone Valley and the area of the animals' summer range unsuitable for winter range for deer.

MIGRATIONS EXPLAINED BY FOOD HABITS

The writer is convinced that the prime cause of migration is the search for suitable food. The elk is primarily a grazing animal, although somewhat partial to browse in addition. Its winter range in the Jackson Hole region must supply grass. The fall migration is more or less coincident with heavy snowfall, and the animals stop for the winter in the first area found in which depth of snow permits winter grazing. In the Olympic Mountains, elk forage is a little different in character, for there the migration is merely an altitudinal change, just enough to avoid the permanent snow belt. The mountain sheep is a grazing animal and finds it necessary to make merely local adjustments within its mountain habitat, seeking the windswept areas where it may reach its favorite food plants. The moose is primarily a browser. Its long legs adapt it for the struggle with deep snow and its food—willows, birches, certain conifers, as well as other forms of browse—are plentiful everywhere. There is no need to wander afar to a winter range, and the moose does not do so.

In the case of the caribou, climatic conditions sometimes affect the availability of food; and, as an example, caribou that summer on the south slopes of the Alaska Range in the Mount McKinley district, a region of heavy snowfall, move over to the north side on the approach of winter, where the snowfall is much lighter. In the Mount McKinley Park section there is a definite movement from the grassy ranges of summer to the more essentially lichen winter ranges.

Such instances, however, do not appear to be important considerations in accounting for the caribou's unusual migratory movements, for large herds of these animals sometimes leave areas where lichens are plentiful and then travel many hundreds of miles to other areas where conditions are much the same. It is thus necessary to give some thought to the specialized food habits of the caribou as correlated with their migrations, in which they are perhaps more highly specialized than any other North American ungulates.

Lichen growth is very slow. Palmer (1926, p. 27) says:

On the basis of the foregoing rates of growth and recovery, it would usually require 7 to 10 years of protection for a lichen range to come back to normal volume following initial growth; and 15 to 20 years to attain a normal height of 4 to 5 inches.

Palmer had not completed his studies, but it is clear that recovery of lichen growth is extremely slow, and that concentration of herds on one range for any length of time would be disastrous to the stand. Not only would the forage be cropped close, but much would be destroyed by constant trampling. Caribou thus require an extensive range. From his studies on reindeer, Palmer concluded that proper use of the range requires 40 to 60 acres per head for year-long grazing, varying somewhat with types of range. Therefore, the fact that the caribou do not linger in any one locality, but are nearly always on the move, keeps them distributed over a wide territory and tends to preserve their winter food.

It is not contended, of course, that the caribou migrations are the result of any intelligent purpose on the part of the individual animals, but it appears to represent a habit built up by racial experience over a long period, during which many lean seasons caused by overgrazing repeatedly forced the animals to seek new ranges. Considering the nature of the lichen forage and the severity of conditions that would result from its failure, it is logical to conclude that adaptive habits meeting these conditions would become fixed in the caribou's inheritance. Without attempting to discuss the mechanism or nature of such adaptation, it is sufficient to note its presence and its importance in caribou economy. The restlessness of the animal is a favorable factor. With less "home range" than any other of our animals, always roving, shifting from place to place, its very manner of eating tends to keep it on the move. The animal nibbles along, taking a bite here and there, apparently intent on reaching some other point. There are, of course, exceptions to this general behavior, as when a group of animals linger for a considerable time in a favorable patch of feed.

Such mannerisms are, indeed, not confined to caribou. Deer and elk are dainty feeders. They do not usually eat a whole plant, but pick a leaf or blade here and there, so that as a rule the effect of their grazing is not always noticeable. This type of grazing (when the range is not overcrowded) naturally tends to favor continued plant growth, and it would seem that the tendency to consider distant pastures more green is a wise bit of natural economy. It would appear then that the caribou really has a tendency that is more or less common to the deer family, but especially developed to meet its peculiar food conditions.

Some unusual situations should be taken into account in this discussion. On the Alaska Peninsula and on Unimak Island, lichens are not present in any quantity (p. 39). Such, apparently, is also the case in Greenland, possibly also in some other localities. Yet the caribou survive. These places, however, are a relatively small portion of the total circumpolar range of the caribou, and on the Alaska Peninsula and Unimak Island bearberry and crowberry, which are evergreen, are unusually abundant and serve as substitutes. A caribou will exist on food other than lichens, as shown by experiments with domestic reindeer and captive caribou, which have been taught to eat alfalfa hay and other feeds. In such cases, however, it is usually necessary to starve the animals into a change of diet. This illustrates their strong desire for the normal winter food, and such a desire in itself should be sufficient to establish a habit for its gratification.

It might reasonably be asked, "Why should the caribou sometimes begin extensive migrations late in July or early in August? Why not wait until late fall?"

The answer is indicated by the fact that about the first of August it is noticeable that a slight change comes over the vegetation. Both among the caribou and the elk the writer has noted an early restlessness coinciding with the time of the first "turning" of the vegetation. There may have been a few frosts at night. Here and there a slight tinge of autumn color may be found among the willows, a slight change in the grasses, not noticeable to the casual traveler, but discernible when looked for. This was noted both in Alaska and also on the elk ranges in Wyoming. Early frosts are local in their intensities. As time passes it is noticeable that vegetation in the open is seriously affected, while the sheltered woodland vegetation is still green. Certain plants have been observed on a mountain side in Wyoming completely dried up, without having produced seed, while a higher belt contained green and flourishing plants of the same forms.

The vegetation touched by early frosts becomes less palatable, and the animals, elk or caribou, wander in search of spots less affected, or where the vegetation is still unchanged. At such times the writer has noted that elk appear to seek wooded areas more generally than during summer, and the caribou have been observed seeking the boggy spots, the seepage at the base of slopes, where the plant growth is still conspicuously green, and later seeking the lichen patches. The partial failure of the accustomed fresh succulent summer forage would thus appear reason enough for the animals to wander, to "pick over" the range for a more palatable supply.

Later comes the shedding of velvet and the general unrest of the rutting season, and the potency at this season of physiological changes caused by the secretion of hormones should not be ignored. Undoubtedly such internal changes have a profound effect on the animal—causing change of disposition, physical appearance, and wanderings.

But are not such wanderings local? And is it possible to find an environment capable of quieting this internal disturbance?

It seems reasonable to conclude that the physiological disturbance of the rutting season could not be brought into equilibrium by any

climatic change, but rather by actual breeding or the passing of time. The moose wanders locally during the rut, but performs no striking migration, since its food is everywhere available. The elk travels about during the rut, but the real migration takes place afterward.

The explanation of the caribou migration may then be summarized as follows: Late in summer there is a general searching for better food, necessitated by local failure or seasonal changes of the vegetation. Local wanderings then take on the nature of a migration, probably at first to reach the lichen areas, and later they are augmented by the general unrest of the rutting activities. By that time the migration has a definite form, and the animals retrace their ancestral routes.

We know that mammals regulate their movements to a large degree by habit. Even many of the smaller mammals travel repeatedly over the same routes more or less regularly as a matter of routine. It is only logical to conclude that the larger migratory mammals would be governed by habit in traversing their annual migratory routes and in reaching their various destinations.

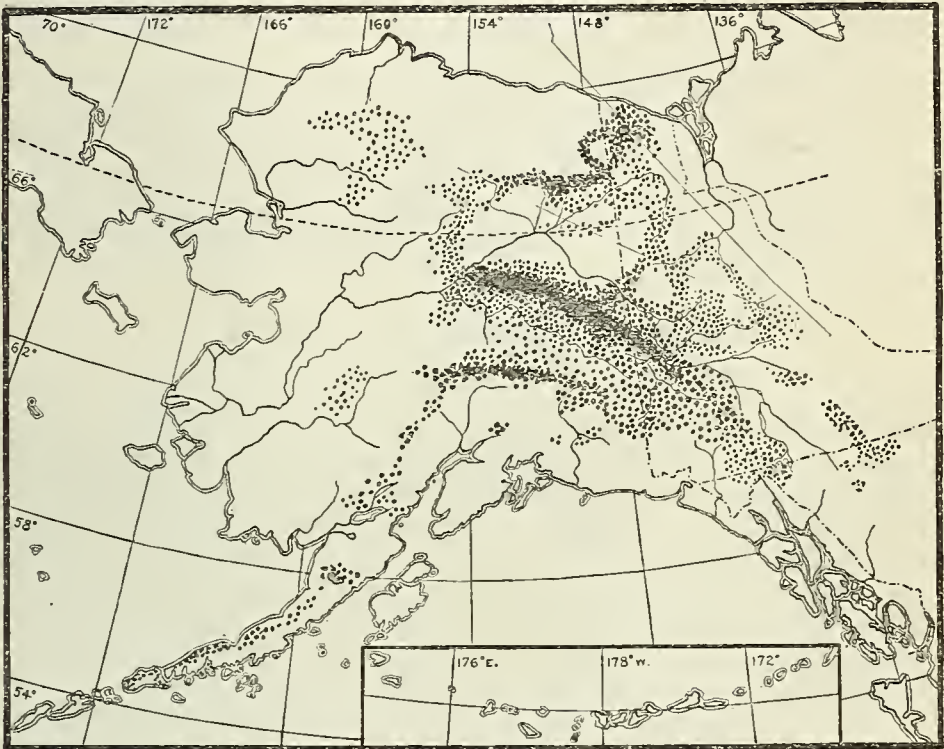
Apparently each species adopts a particular migratory habit to suit its food requirements. In the case of the caribou the need appears to be an avoidance of concentration, and the need for greater dispersal of the caribou has been met by greater restlessness, resulting in a greater and more varied migration. Throughout its circumpolar range, the caribou normally seeks lichens for winter forage, and throughout its entire range it is a wanderer. These two facts appear to be related, and in the absence of any other solution it seems reasonable to conclude that the caribou's peculiar taste has made the species the restless wanderer that it is.

HABITAT

THE CARIBOU A MOUNTAIN ANIMAL

The Alaska-Yukon caribou are essentially mountain-dwelling animals. Although in certain areas they occur in the lowlands normally, and will, indeed, visit low country more or less regularly at certain seasons, they spend most of their time in the mountains. The areas of concentration practically outline the main divides between river systems (fig. 14). Thus, the Yukon-Tanana herds occupy the high plateau region north of the Tanana, the center of abundance being the high divide between the Yukon and Tanana, and to the east in Yukon Territory a similar type of country is found as far as the herds go. The northern herds likewise cling to the mountains of the Brooks Range and in their southward movement also follow a divide—that between the Koyukuk and Chandalar Rivers. The tendency toward mingling of these two groups in Alaska takes place by means of the only mountainous routes available—near Rampart, where more or less rugged topography reaches the Yukon from both sides. Eastward lie the extensive Yukon Flats, which the caribou normally avoid. Westward the north side of the Yukon still remains mountainous or hilly, but to the south lie extensive flats. No caribou are found crossing the Yukon east of the Rampart section until one passes Circle, and here again are mountains. Further

explanation will clarify this matter. Caribou are often found in low country; many cross the Tanana Valley, which is also wooded. The animals are frequently found in low marshy spots within the mountain areas, and assuredly they occur on the tundra of the Arctic coast. Such occurrence, moreover, is perfectly normal, no doubt in response to desires on the part of the herds. Considering, however, the sum total of caribou activity and the animal's preference, as nearly as it can be interpreted, one concludes that the highlands play a much greater part in the animal's life, and it is there that one normally seeks the caribou.



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FIGURE 14.—Present-day distribution of Alaska-Yukon caribou, density of spotting indicating relative abundance.

Much of the area in the mountains occupied by caribou is above timber line. In the Alaska Range this is most clearly evident, for the fairly large herds of Mount McKinley National Park are almost exclusively in the open country, since very little timber is found within the park boundary. In the Yukon-Tanana region unforested areas are rather intermittent, for spruce woods follow all the ramifications of the stream valleys among the mountains, and it may be said that mountain tops here merely rise above the general forest level. The main divide, however, is fairly continuous open country. Moreover, almost anywhere in this region it is possible to find a hill-top from which, looking away toward the horizon, one gets the impression of open country, since comparatively little of the forest is in sight from such a viewpoint. The caribou trails that show the greatest use are in open country.

Caribou, however, are not confined to the sections above timber line. Many observations of their movements show that there is no

disinclination on their part to enter the woods. A band, for instance, coming along a ridge, in the direction of travel of the migrating herds, may come to a split in the ridge, branches leading around to either side and one of them connecting again with a ridge farther on, which once more leads in the desired direction. To follow the open ridge means a great detour, while to go straight across means to dip down into the timbered valley with a stiff climb on the other side. In many such situations well-worn trails lead along the lateral ridge, with the wide detour, sometimes cutting off a little by dropping down from the crest on the inside curve. On the other hand, caribou trails, perhaps not so well worn, also lead straight down through the valley, and caribou have been observed using both to regain their routes on the open ridges.

In seeking food caribou are likely to be in a variety of situations, but as a rule they are found feeding on the lichen patches of the high bare slopes. The animals frequently descend into the spruce forest, where they may find mushrooms or good patches of lichens. Many fairly open forested areas in Alaska, usually of scrub spruce, contain excellent growths of lichens, and these attract the caribou, summer or winter.

PHYSICAL FEATURES OF ALASKA

MOUNTAINS

Alaska (fig. 15) is traversed by two extensive mountain regions. The more southerly, which has been designated the Pacific mountain system, extends in a general east-and-west direction, a continuation of the Pacific coast ranges of the continent. Roughly crescent shaped, it follows the curvature of the southern Alaskan coast, from southeastern Alaska to the Aleutians, including the Coast Range, the St. Elias Range, the Aleutian Range, and farther inland the parallel Alaska Range. In this group of mountain ranges are some of the highest peaks on the continent, including Mount McKinley, 20,300 feet; Mount St. Elias, about 18,000 feet; and Mount Logan, about 19,500 feet. This region also includes the well-known Alaskan coastal glaciers.

Another mountain chain, north of the Arctic Circle, the Brooks Range, also crosses Alaska in an east-and-west direction, roughly following the sixty-seventh degree of latitude. Rising 3,000 to 4,000 feet on the average, with peaks reaching over 7,000 feet in altitude near its eastern end, it is by some considered to be a continuation of the continental Rocky Mountain system. It includes the Endicott, De Long, and Baird Mountains, as well as lesser groups, and terminates in the vicinity of Kotzebue Sound, the elevation diminishing westward.

INTERIOR PLATEAU

Between the Brooks Range on the north and the Alaska Range on the south lies an extensive plateau country, occupied in the interior by the Yukon and Kuskokwim River systems. The demarcation between the boundary mountains on either side and the interior plateau is quite abrupt. This central plateau area, like the mountains, also reaches its greatest elevation toward the east, where the upland between the Yukon and Tanana Rivers maintains an altitude of 2,000





FIGURE 15.—Physiographic features of Alaska and adjacent parts of Yukon important in the distribution of the caribou.

to 3,000 feet, interrupted by higher points along the main divide, parts of which become somewhat rugged. Large lowland areas occur in this region, such as the Yukon Flats, which occupy an area 200 by 100 miles in greatest dimensions; the Tanana Valley, traversed by the Tanana River; and certain sections in the upper Kuskokwim Valley; as well as minor areas of less extent. The interior is thus a region of varied relief, with extensive areas of rolling hills interrupted by lowlands, and with the general elevation diminishing westward until the marshy coastal plain of Bering Sea is reached. In these lowland areas there are numerous streams of varying size, many small ponds and minor lakes, as well as some lakes several miles in extent, but no large ones.

THE WEST COAST

To the west the upland of the interior plateau gives way to extensive marshy areas merging into the coastal plain of Bering Sea, which is particularly wide near the mouths of the Kuskokwim and Yukon Rivers, and in general is characterized by lakes and sloughs. To the northward, the low coastal plain ends near St. Michael Island and the shore is formed mainly of the basal slopes of hills and low mountains to beyond Bering Strait and thence becomes a widening plain to the Kotzebue Sound region; from Kotzebue Sound to beyond Cape Lisburne the coast is formed mainly by the low descending hill slopes outlying from the mountains of the neighboring interior. Southward, there is the same progressive diminution of the plain that extends along the Alaska Peninsula as a strip bordering the Bering Sea coast all the way to the western tip, and is also represented on Unimak Island.

THE ARCTIC SLOPE

North of the Brooks Range, from somewhat east of Cape Lisburne to Point Barrow and thence eastward to the Canadian boundary, is found another region of low relief, generally referred to as the Arctic slope. This consists of a rolling plateau bordering the mountains, dropping to a lower plateau by an escarpment to the north, this area giving way in turn to the coastal plain bordering the Arctic Ocean. The Arctic slope is part of the circumpolar tundra belt, and is nearly continuous with a similar area in northern Canada. It becomes quite narrow, however, in the vicinity of the international boundary, where the mountains rather closely approach the sea.

CLIMATE

SOUTHERN ALASKA

The greatest contrast in Alaskan climatic conditions is occasioned by the Pacific mountain system, more especially the Alaska Range, separating the humid, milder coastal districts from the drier, colder interior. Southeastern Alaska has a climate roughly comparable with that of Puget Sound. The glacier section of southern Alaska is somewhat colder, with a heavy precipitation, the annual rainfall sometimes reaching nearly 200 inches. Westward the precipitation is lighter, probably about 80 inches in the Aleutian district. On the

western end of the Alaska Peninsula and on the Aleutians, cloudy and foggy weather prevails. Temperatures are not extreme, but storms are common and violent, especially in winter.

THE INTERIOR

Interior Alaska, from the Alaska Range northward, has a climate roughly comparable with that of other subarctic provinces, although winter temperatures in interior Alaska and parts of Yukon Territory probably average lower than any other section to the east or north. According to Cleveland Abbe, Jr. (Brooks, 1906, p. 147), the temperature here may reach -80° F., though this must be extremely rare, while temperatures of -40° or -50° are common. Westward to the Bering Sea coast, the minimum temperatures become higher, but in the same proportion winter storms are more prevalent.

Summer temperatures in the interior may reach 90° or possibly 100° F., and there are often rather long periods of extremely warm weather. Killing frosts may occur in August, and the growing season varies, according to locality and character of season, from less than 60 days to more than 100. In this region, however, a short growing season is compensated for by the long hours of sunlight, the sun at this season being below the horizon only a short time each day.

The precipitation of the interior mountain region in Alaska is not great. According to some records it varies from 11.35 inches for the year, as at Eagle, to about 25 inches, near Bering Sea. Seasons vary greatly. Some summers are especially rainy, and many appear to be so, even though the total precipitation may be small. The season of 1923, on the other hand, was extremely dry, with persistent high temperatures.

THE ARCTIC SLOPE

The Arctic slope has a lower average precipitation than any other section of Alaska, the average along the Arctic coast being between 6 and 7.5 inches. The minimum temperature does not go much lower than -55° F., while the maximum is probably about 65° , resulting in a temperature range much less than that of the interior. Violent storms, however, offset the somewhat higher winter temperatures.

VEGETATION

The greatest contrast in types of vegetation in Alaska is found between the humid Pacific coastal belt, with its characteristic heavy forests and rank growth, and the more arid interior, which has a plant growth characteristic of the subarctic areas of North America. In a discussion of the caribou, the Pacific coastal area is not important. The plant growth of the interior, however, and that of the Bering Sea coastal region, are of great importance.

The northern forests, from the Alaska Range northward, consist chiefly of white spruce (*Picea canadensis*) and black spruce (*P. mariana*) (pl. 10), with white birch (*Betula papyrifera*) next in abundance. Birches are particularly abundant in the vicinity of Lake Minchumina, where they may be found locally in pure stands. Burned-over spruce woods are often replaced extensively with birch. Tamarack (*Larix americana*) occurs more sparingly. It is found



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Characteristic black spruce forests of caribou range in Chatanika Valley, in interior Alaska: *A*, In February. *B*, In September.



locally throughout the Tanana Valley and upper Kuskokwim region, probably also in limited quantities elsewhere. Aspen (*Populus tremuloides*) grows conspicuously on dry hillsides, noticeably on steep slopes along the Yukon, Tanana, Porcupine, and other rivers. Often this tree occurs together with birch in suitable soil. Balsam poplar (*P. balsamifera*) is more localized in distribution, but is by no means uncommon. It is particularly noticeable on the banks of streams. Forest trees of the interior are small, the white spruce on the banks of streams attaining an extreme diameter of 2½ feet, occurring in almost pure stands in places on the lower Yukon. According to Eskimo information, poplars appear on the Arctic slope of the Endicott Mountains, where spruce apparently is absent.

A mixed forest is the rule. Especially noticeable is the mixture of white spruce and birch, which forms a rather definite forest type. Growth is more dense on stream banks, where white spruce attains its greatest size, and similar conditions may occur on certain favored slopes. In general, the forest growth on the flat lowlands is much scattered, and the trees (black spruce in swampy areas) are small and stunted, with the usual diameter 5 to 8 inches, the maximum scarcely reaching 12 inches. Large sections of the interior have been burned over, leaving an unsightly waste of blackened poles.

The western forest edge is uneven, being broken by indentations of the coastal tundra area. It extends as far as Andreefski on the Yukon; to the shore of Norton Sound north of Unalakleet; to the west coast of Norton Bay; to Bethel on the Kuskokwim; and is represented sparsely to the vicinity of Becharof Lake on the Alaska Peninsula.

Northward the spruce forest reaches up the stream valleys on the south slope to the vicinity of the mountain summits of the Brooks Range. Throughout the forested area bare hilltops or rocky ridges rise above timber line. In some sections of the Yukon-Tanana upland one may look across the rolling hills from a high point and hardly be aware of the forest, although it is found at once if one descends into the stream valleys. Timber line varies greatly, occurring at elevations from 1,000 to more than 2,000 feet, even at 3,000 feet or more, to the north.

Throughout the forested region, as well as on the tundra beyond its boundaries, many varieties of willows abound, ranging in size from the large *Salix alaxensis* of the bottom lands to the tiny *S. reticulata*, which occurs beyond forest growth. The immediate borders of many streams that are devoid of trees are clothed in a dense mass of willows. Sloughs and lakes of the Bering Sea tundra region are heavily bordered with willow growth, while the Arctic slope of the Brooks Range supports a growth of large willows in lieu of forest. On the tundra itself several species of willows form a part, in varying degree, of the typical vegetation.

Alders (*Alnus* sp.) form a somewhat lesser part of the undergrowth of the interior, but on the Alaska Peninsula and the coast of Bering Sea they replace the larger willows and take the place of the forest in sheltered places. Here they are distributed in irregular patches and belts at the base of the mountains in valley margins, and in gulches along the coast.

Other forms of wide distribution are *Betula rotundifolia*, *Cornus stolonifera*, *Viburnum pauciflorum*, *Ledum groenlandicum*, *L. palustre*, *Dasiphora fruticosa*, *Vaccinium vitis-idaea*, *Rhododendron lapponicum*, and *Empetrum nigrum*—all readily recognized as typical subarctic forms. Sedges are plentiful on tundra as well as on lake shores and in the marshes of the interior. Grasses are numerous and in some sections form an exceptionally heavy growth—for example in Mosquito Flats of the Fortymile district, and in parts of the Alaska Peninsula and the Aleutians.

Of particular interest in the present study are the numerous lichens. Lichen growth is abundant, in many areas grows luxuriantly, and probably occurs over most of interior and northern Alaska. The strictly coastal areas of Bering Sea and the Arctic Ocean appear less plentifully supplied, but wherever one reaches higher ground, lichens again appear. There are many forms, including *Cladonia*, *Cetraria*, and *Thamnolia*. From the standpoint of caribou food the species of *Cladonia* are the most important (p. 36).

DISTRIBUTION AND MIGRATION OF HERDS

It is evident that nearly all of Alaska and Yukon Territory is included in the caribou range of recent times. Although in many sections caribou do not now occur, there is evidence that these areas have been occupied within fairly recent years; but probably not all simultaneously. The shifting herds have left some areas vacant for years, then returned to them for another period, leaving other sections, in turn, unoccupied. It would be detrimental to the welfare of the herds were the entire available range utilized continuously (p. 48).

East-central Alaska and western Yukon form the center of abundance of the caribou. Westward they diminish in numbers, and they are now almost if not quite absent on the Bering Sea coast. They are not found in southeastern Alaska but approach near the coast of south-central Alaska. At one time they inhabited Kenai Peninsula, and they are still found on Alaska Peninsula and on Unimak Island, the westernmost point reached by caribou. The Arctic slope is caribou range, though it is not extensively occupied at present. On the east, in Yukon, caribou again decrease in numbers in the vicinity of the Mackenzie River, which separates the Alaska-Yukon herds from those of central-northern Canada.

The Alaskan caribou fall naturally into several more or less distinct groups of closely related herds, but it must be understood that the various groups of herds are not completely isolated from each other in all cases. Under the present state of classification it is difficult to apply the various specific names (p. 73) available in the discussion of distribution, since nomenclature and herd assortment do not agree in all cases. Therefore, the individual herds are designated by the territory principally occupied by each, as follows:

Alaska Peninsula herds—caribou occupying Alaska Peninsula and Unimak Island.

Bering Seacoast herds—scattered bands distributed over a wide area. While today these do not constitute herds in any sense of the word, they are most conveniently dealt with together.

Alaska Range herds—caribou bands scattered along the Alaska Range.

Northern herds—the animals ranging along the Endicott Mountains, through the upper Koyukuk and Chandalar watershed, across the Porcupine into Yukon Territory. In this group will also be included the scattered animals still remaining on the Arctic slope.

Yukon-Tanana herds—the largest group, occupying mainly the Yukon-Tanana upland and contiguous areas in Yukon Territory.

Smaller groups of herds and scattered individuals occur here and there throughout the territory. These are considered in connection with the neighboring large groups. A general picture of the migrations of the principal herds is shown in figure 16.



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FIGURE 16. Fall migrations of caribou in Alaska and Yukon Territory. Spring migrations tend to be the reverse of the fall movements but more gradual, scattered, and obscure.

ALASKA PENINSULA HERDS

OCCURRENCE

At one time caribou were abundant throughout the length of the Alaska Peninsula. Nelson (1888, p. 285) says:

In Alaska they are found along the Pacific Coast from a point nearly opposite Kadiak Island west to the island of Unimak, and thence all around the Alaskan shore of Bering Sea and the Arctic, in the treeless belt which borders all of this coast line.

The animal "is also numerous on Nunivak Island but on none of the other Bering Sea islands is it found."

Ivan Petroff (1884, p. 25) says that "reindeer" (i. e., caribou) were plentiful in the mountains back of Katmai, and speaking of the base of the peninsula in general, says that they were common, being found high in the mountains in summer, in the lowland in fall and winter.

L. M. Turner (1886, p. 203) wrote that the caribou was not known to occur north of the headwaters of the Tanana River. It was, however, plentiful "about the interior back of Bristol Bay and thence south."

At present the numbers on the peninsula have dwindled greatly, but a few herds are still holding their own. One herd, numbering possibly 2,500, ranges from Morzhovoi Bay to Herenden Bay, with the center of abundance in the vicinity of Pavlof Valley. The other herd, apparently a little larger, ranges from Moller Bay to the vicinity of Black Lake. The latter herd appears to be less molested by hunters than the others, but as a whole the caribou of the peninsula have been and are rapidly dwindling.

Various accounts indicate that the animals range high in summer and in the lowland during winter. No winter observations were made on the peninsula, but in spring the caribou were found seeking new green vegetation in the lowland marshes and the valley bottoms within the mountains. A number were seen there also in mid-summer.

Caribou are scarce to the eastward of Port Heiden, but a few have been recorded as far east as Becharof Lake in comparatively recent years. (Osgood, 1904, p. 28.)

Several islands adjacent to the peninsula were inhabited at one time. Caribou occurred in considerable numbers on Unga Island, according to A. J. Stone (Allen, 1902a, p. 127), and Deer Island is also said to have had caribou, but today none are found on either. In July 1925 a caribou skeleton was found on Amak Island, 12 or 14 miles off the Bering Sea shore. It was practically buried in a heavy growth of moss and other vegetation. Part of an antler from another animal also was found. This island cannot be much over 2 miles square.

Unimak Island, roughly 30 by 75 miles in extent, represents the westernmost point of distribution for caribou and harbors a group that has been estimated at from 7,000 to 10,000 animals; a visit to the island in 1925 inclines the writer to favor the lower figure. This herd, located within the boundaries of the Aleutian Islands Reservation, appears to have fared better than those on the Alaska Peninsula. The principal range on the island, as on the peninsula, lies on the Bering Sea side, and the center of abundance is Urilia Bay. The animals occur also in the mountainous interior of the island, the western end bordering Unimak Pass, and at Unimak Bay and along Isanotski Strait, appearing in some of these places only at certain seasons of the year.

The numbers of these island caribou have fluctuated considerably. The late Donald H. Stevenson, reservation warden of the Biological Survey, during a number of years' residence on the Aleutian Islands compiled information on the history of this herd from various trappers, Aleuts, and other residents. According to his field reports, in the eighties and in the early nineties the herd was decreasing rapidly until in 1894 only a few hundred remained. During this time a sea-otter hunting station had been maintained in Isanotski Strait, a base from which hunters worked out around the island, using the native type of huts at intervals for hunting camps. It was thought that these activities resulted in the killing of many caribou for food.

Then, possibly owing to lessened activities of sea-otter hunters and no doubt to other causes also, the caribou commenced to increase and an additional influx from the peninsula swelled the numbers, until by 1905 the island held all that the range could carry. About 1908 they again began to decline in numbers, but soon were able to hold their own and later increased once more.

MIGRATIONS

According to various reports there is a local caribou migration on Unimak Island. In fall bands of caribou travel from the vicinity of Urilia Bay eastward to St. Catherine Cove, thence along Isanotski Strait to Ikatan Peninsula. No doubt a parallel course is taken by others farther inland. At Seal Cape a trapper reported that during the first severe winter storms of 1920, beginning about December 17, he observed about 2,500 caribou traveling in a westerly direction. They continued to come by in groups of 10 or 15 until Christmas time, and during the remainder of the winter caribou could generally be found near his camp. A reverse movement is said by some to take place in spring, but these travels are not well known in detail. There is little information from the western and southern parts of the island.

At one time there was a more or less regular crossing between Alaska Peninsula and Unimak Island. Petroff (1884, p. 19) says:

* * * large herds of reindeer formerly came down at regular intervals from the upper peninsula to its westernmost point, and even crossed the strait to Oonimak [sic] Island, but of late, for some cause unknown, they have failed to make their appearance.

Migration over Isanotski Strait has been intermittent. In 1925 local residents informed the writer that no extensive migration of this character had taken place since 1908. Since that year a few have crossed in both directions; 46 animals were observed swimming over near St. Catherine Cove in December 1916, and other reports indicate a crossing from Unimak Island to the peninsula as late as the winter of 1931-32.

Apparently there have been general movements of animals lengthwise of the Alaska Peninsula, as suggested by Petroff, but little definite information is available. There seems no doubt that at the time of great abundance the peninsular caribou were connected rather definitely with those farther back from the mainland coast. They are scarce at the base of the peninsula now, but older records show that this was not always the case. Nelson's report (1888) indicates a rather continuous distribution from peninsula to mainland and the Bering Sea coast in general. A reindeer owner told the writer that in early times a small number of caribou, probably a few hundred, traveled between Nushagak and the Alaska Peninsula. One prospector had a similar report that a slight migration had taken place along the base of the Alaska Peninsula on the Bering Sea side.

A mere remnant of former herds now remains, and naturally no extensive or conspicuous migrations are in evidence. Moreover these animals became reduced in numbers so soon after the American occupation that information is necessarily meager and lacking in detail. During periods of great abundance one would expect pronounced migrations and intercommunication of herds. Such

periods date back so far that they have almost escaped historic record. With the information available, however, it seems certain that there has been free communication between the animals living on the Alaska Peninsula and coastal herds to the north, as well as more inland herds. It is not impossible that the antlers shown in figure 11, *A*, from Nelson's Lagoon, represent an animal whose ancestry would reveal close relationship with the animals of the Alaska Peninsula.

BERING SEACOAST HERDS

OCCURRENCE

Caribou are now so scarce in the lowland areas bordering Bering Sea from Bristol Bay to Bering Strait that they cannot be designated as a distinct herd, but in view of their former abundance and the scattered animals still remaining, this area merits consideration.

According to Nelson (1888, p. 285):

When the American Telegraph explorers visited Alaska in 1866-67, reindeer were found everywhere, and herds containing thousands of individuals were no uncommon sight. They were very abundant on the hills and valleys bordering upon Norton Sound, but today their former abundance is indicated only by the number of antlers scattered over the country and the well-marked trails worn on the hillsides or leading across the valleys, showing where they passed from one feeding ground to another.

Even at the time of Nelson's explorations, 1877-81, the herds were disappearing. He states that one winter, just before the transfer of the Territory from Russia, "an enormous herd of reindeer passed so near St. Michael that a 6-pounder loaded with buckshot was fired at them, killing and wounding a number of them." Yet throughout his explorations in this section where they had been so abundant, he failed to see a single living caribou, although tracks were seen and a few animals were killed by hunters within 50 miles of St. Michael.

Nunivak Island was inhabited by many thousands of caribou as late as 1878. Following the practical disappearance of caribou along the western coast of the mainland, hunting parties of Eskimos from as far north as Kotzebue Sound made yearly trips to the island and so persistently killed them for their skins that they were finally exterminated from the island. According to Petroff (1884)—

along the mountain range extending between the Kuskokwim and Togiak Rivers, and impinging upon the sea at Cape Newenham, reindeer are plenty, and are hunted constantly by the natives on both sides of the divide.

The same writer states that natives along the coast between Togiak River and Nushagak hunted the animals.

Osgood (1904, p. 27) reported signs of caribou at the upper end of Lake Clark and along Chulitna and Kakhtul Rivers, and a few are still found in this section and in the area south of the lower Kuskokwim, principally back toward the mountains. They occur at the heads of Stony, Aniak, and Mulchatna Rivers. George Peterson, who acted as guide during these investigations in 1924, said that they were common on the tundra about the lower Yukon and Kuskokwim 25 years earlier and were much more plentiful before that. On upper Kokechik River, near Hooper Bay, old trails were found, which Peterson declared were caribou trails. They could have been nothing

else. In 1910 about 25 were reported on the Yukon Delta, and in 1914 there were 5 to 10, according to A. H. Twitcheil, but there are none remaining now. An Eskimo at the village of Pimiut, on the lower Yukon, told the writer that caribou were plentiful in that section "when he was a boy."

A favorite range for caribou of this general region is the area of rolling hills adjacent to and including Beaver Mountains, partly wooded, which lies between the mining towns of Ophir and Flat. Only a few stragglers remain, and the principal range is now occupied by domestic reindeer herds. Caribou are found in limited numbers south and east of Kaiyuh Mountains in the area between Moore Creek and the mouth of Iditarod River, some in the Cripple Creek hills northwest of McGrath, and a small bunch on Nixon Fork.

Caribou also regularly occur near Peluk Creek, on the flats, about 20 miles northwest of Farewell Mountains, of the Alaska Range. Another area 20 to 30 miles southwest of Lake Minchumina is still occupied regularly by a few bands. These animals, however, are near the Alaska Range and are no doubt more or less recruited from the herds inhabiting these mountains.

Various reports from residents agreed that 20 to 30 years prior to 1927 caribou were much more common in the country north of the lower Yukon and inland from Norton Sound. They may still be found in the hills of that region, particularly at the head of Unalakleet and neighboring rivers. Caribou are thus entirely absent or occur only as stragglers on the Bering Sea coast, in most of the Kuskokwim region, along the lower Yukon, and in the vicinity of Norton Sound, and much of this area is now occupied by domestic reindeer.

MIGRATION

A reindeer owner in the Beaver Mountains was informed by old natives that in former years caribou had crossed the Yukon near Andreafski, had traveled to the Kuskokwim River, crossed it, and reached the Canyon Creek region, and he was of the opinion that a few still come over this route. Nelson has informed the writer that "the Russians and Eskimos at St. Michael in 1877 said the caribou used to migrate along the coast northward by St. Michael usually in the fall." This indicates a general north and south route of migration, at least from Norton Sound to the vicinity of Kuskokwim Bay. Information, however, is meager on this point. The facts regarding the complete migrations, as well as detailed distribution in the days of their abundance, are lost to us forever.

ALASKA RANGE HERDS

OCCURRENCE

Caribou inhabit the Alaska Range throughout its entire length, not as one continuous herd, but as occasional groups of varying size, with the center of abundance in the region east of Mount McKinley. To the west of Mount McKinley the animals are not abundant. A few hundred live in the Rainy Pass district, about Post and Hartman Rivers, Farewell Mountains, and in autumn about the head of Happy River. The Rainy Pass vicinity is the center of abundance in the

western part of the range. West of this point they occur in diminishing numbers, being found principally in localities at the heads of Stony, Aniak, and Mulchatna Rivers and the Lakes Clark and Iliamna (p. 60). The animals ranging through the flats near Peluk Creek and Lake Minchumina are no doubt recruited from the Alaska Range nearby. The animals ranging west of Mount McKinley total about 3,000.

The principal aggregation of the whole Alaska Range is confined to the area now included in Mount McKinley National Park. H. P. Karstens, a former superintendent of the park, has estimated that there are 20,000 head, which he suggests is probably conservative. East of the park these animals are found more sparingly. On the upper Delta River they again become locally common, but still farther east appear to be more scarce. In the spring of 1921 a few were found on Robertson River, and it is believed that there are only small groups and scattered individuals in this part of the mountain range during summer. In autumn there is an influx of animals from the Yukon-Tanana upland (p. 69).

Although it is difficult to form even an approximate estimate, the resident caribou of the Alaska Range probably total 25,000 to 30,000 animals.

SUMMER RANGE

Over much of this territory it is difficult, with information at hand, to indicate the summer and winter ranges, but in some localities this may be done approximately. It can be said, however, that in general the summer feeding grounds of the caribou of the Alaska Range lie in the higher parts of the mountains.

On the upper Delta River caribou are found the year round, and there is probably a little seasonal shifting to different ground, but on this point no information is available. In Mount McKinley Park more definite observation was possible. In summer the caribou ascend high into the mountains, feeding on the green slopes of upper Savage and Sanctuary Rivers and other streams and are often found in the high passes on upper Teklanika and Toklat Rivers. At this season they may be found on the glaciers, and some even cross to the south side of the Alaska Range as far as Peters Hills and the vicinity of Peters Creek. An old resident said that he had seen "thousands" at the head of Yentna River in summer. In the Rainy Pass region the animals cross the range as far as upper Happy River.

WINTER RANGE

The heavy snowfall of the south slopes in winter forces the caribou to leave for the north side, and furthermore the majority descend to the lower foothills, where the lichens furnish winter feed. In the Kantishna district a favorite winter range lies about Stony, Myrtle, Moonlight, and Clearwater Creeks, tributaries of the Toklat River, as well as in the vicinity of Chitsia Mountain. Tracks were found on the Toklat as far down as the vicinity of its tributary, Sushana River, which appears to be about the limit of distribution northward. In "early times", it is said by residents, the Kantishna Hills were largely inhabited by caribou. This is not now the case, unless the increase in the herds and changing migrations have very recently caused them to occupy this locality again in some numbers.

In Rainy Pass, west of Mount McKinley, upon the arrival of winter the caribou leave Happy River, where they generally occur in fall. On Post River, tributary of South Fork of the Kuskokwim, they were found in February living on a range of low rounded hills, where they had pawed deep holes in the snow for the lichens. Extensive areas of snow were packed hard where the animals had been traveling and feeding through the winter. The flats about Peluk Creek and near Lake Minehumina, partly covered with a thin stand of scrubby spruce, contain lichens that attract a limited number of caribou in winter.

MIGRATIONS

Upon the arrival of the first snow in fall, or late summer, or when early frosts have begun to turn the vegetation slightly yellow, the caribou tend to forsake the high mountains. One summer, snow fell on upper Savage River late in August. Since lichens are not plentiful in these high valleys and slopes, and other vegetation has become less palatable, the animals naturally begin to turn their attention to the winter food at lower elevations. The change is not abrupt, however, and it is only when the desire for new feeding grounds is augmented by the unrest of the rutting season late in September and in October that a pronounced migration takes place. At that season the animals are sometimes massed in herds numbering several hundred. There is a general trek eastward along the front of the range, in Mount McKinley National Park. Bands of caribou appear at the head of Mauriee Creek and Riley Creek and in the vicinity of Healy on the Nenana River, where they venture into the low country to some extent. To the southward the animals enter Broad Pass, and they have been noted in considerable numbers at Cantwell, Windy, and other neighboring points on the Alaska Railroad. Passing through the Broad Pass region, they move on eastward, but the extent of their travels in that direction is unknown. As a rule they probably do not pass much beyond Mount Hayes. After the rut, the spectacular "run" being over, the animals become distributed over their winter range. Apparently a considerable portion remain within the park or find their way back, but their numbers are no longer concentrated and their movements have become more erratic and the direction less obvious.

NORTHERN HERDS

OCCURRENCE

North of the Yukon the center of abundance of caribou is the highland area, the divide at the heads of the Dall and Hodzana Rivers, the South Fork of the Koyukuk River, Bettles River, and the upper Middle and East Forks of the Chandalar. The abundance decreases eastward to the Canadian border. In Yukon another center of abundance lies about the upper Poreupine River and headwaters of Peel River. These localities, comprising the chief range of this group of herds, have long been established hunting grounds for the natives. The highlands at the head of Dall River have been a source of food supply for natives from the south as well as those from the north, particularly the latter, while those from the middle Chandalar took toll from the east, more particularly on the upper Hodzana. On the upper Chandalar and the upper Koyukuk, caribou may be most con-

veniently obtained from the territory between Coldfoot on the Koyukuk and Big Creek near the Chandalar, or, a little farther north, from Bettles River or the East Fork of the Chandalar. The Yukon Flats, which include the territory of the lower Chandalar and Porcupine Rivers, do not regularly harbor caribou. However, these animals come down to Caro, and some were killed 28 miles north of Beaver, on the Yukon, which is the southernmost point reached in this area. One was killed 6 miles below Fort Yukon in the spring of 1925, and another about 3 miles up from the mouth of Porcupine River. Some also came down Black River in the same spring, a few being killed within 10 or 15 miles of its mouth. These are stray records; an Indian declared that no caribou had been observed "so far down" for the "last one hundred years." Certainly the Yukon Flats are ordinarily avoided by the caribou.

The southern limit of the regularly occupied range corresponds fairly well with the edge of the highland bordering the Yukon Flats. Thus the range extends down the Porcupine River a little below the mouth of Coleen River, and down the Chandalar a little south of Caro. It must be remembered, however, that the animals are here at the edge of their habitat and are not so plentiful as farther toward the center. Reports from trappers and Indians indicate that caribou occur on the Porcupine from the vicinity of Coleen River, all the way up the Porcupine to the Nahoni Lakes, at its head, and on to the upper Peel River, particularly about the Ogilvie, Hart, Wind, and Bonnetplume Rivers. The animals of this region are sometimes referred to as the "Peel River herd." To the northward from Porcupine River, in Canadian territory, caribou are found in the Old Crow River region and on to Herschel Island. A former member of the Royal Northwest mounted police stationed at Herschel Island has found caribou on the mainland opposite the island and eastward to the Mackenzie River Delta.

The group of herds, as outlined here, is fairly continuous from the Peel River district in Yukon, northward, westward, then southward, in a great half circle, until the other limit is reached near the Yukon in the Dall River highlands. Westward from John River, upper Koyukuk district, caribou do not normally occur. In the fall of 1924 they reached Allakaket, a mission and village on the Koyukuk, for the first time in the memory of local Indians. South of this point they occur sparingly on the upper Melozitna and Tozitna Rivers, although the unusual migration of 1924 brought an influx into this region and some even crossed the Yukon into the Nowitna River country.

The caribou of the Arctic slope, a part of this northern group, are now scattered and probably do not assemble to any great extent, unless it be toward the east, near the Canadian border. In northwestern Alaska the distribution is confined to certain favorable localities.

Apparently caribou are not found at present on Seward Peninsula. The writer was told that in the early days, probably in 1899, antlers were found in this region, and early published reports indicate that this area was once occupied. Nelson has informed the writer that formerly caribou were numerous on the upper Kobuk and Noatak Rivers. The Eskimos, he says, "from the upper parts of these rivers

that I saw camped at Hotham Inlet the summer of 1881, had tents and clothing and numerous flat skins of them." S. B. McLenegan (1889) found caribou abundant in the Kobuk River region in 1884, but Joseph Grinnell, who went into the Kobuk country in 1898 and spent the winter there, writes the author that he did not see a live caribou "in all that country." He remarks: "Apparently caribou were rare in that country in the late nineties, and since the Indians all had rifles, I doubt if there has been much, if any, come-back."

In the fall of 1898 a great number of prospectors went from Kotzebue up the Noatak, Kobuk, and Selawik Rivers, the majority going up the Kobuk, and according to one of the prospectors, there were no caribou, mountain sheep were scarce, and many men died of scurvy. The Kobuk and Noatak Basins, apparently, have not been good caribou range since the eighties, and only a few stragglers occur. Occasionally a few wild caribou drift into the reindeer herds at Shungnak on the Kobuk, but nowhere in that section are they abundant enough to be hunted profitably.

On the north slope of the DeLong Mountains caribou are a little more plentiful. A trader on the Yukon who had spent much of his life in the Arctic told the writer that before 1901 caribou were plentiful west of Colville and Chipp Rivers, but that in the years 1901 to 1905 natives from west of the Colville traveled east of that river for caribou, showing that they had already become scarce in that region. In early times, he said, caribou passed near Point Barrow on their westward journey.

In 1923 an Eskimo in the Koyukuk district said that caribou were plentiful in the Colville section "years ago", and he thought they were again becoming more plentiful on the Arctic slope, where they had been scarce for a number of years. A prospector had been at the head of the Noatak in 1901 and found no caribou there, but some Eskimos had crossed over into the Colville Basin and got 15 of a band of 35. One who crossed the range by way of Alatna River in 1911 found caribou sign in the Colville headwaters, and learned from an Eskimo that there were "always lots of caribou in that place." A member of the United States Geological Survey party who spent three seasons north of the range, exploring the Colville River country, found no caribou within 30 or 40 miles of the coast, but in 1925 he found indications of caribou at the head of the Utokok and old trails between the head of this river and the Colville. Natives from Point Lay, Icy Cape, and Wainwright come up the Utokok and also portage over from the Kuk to get caribou on the upper Utokok. In both 1924 and 1925 caribou were common in the Colville watershed, having been found half way up Killik and Chandler Rivers, down the Colville to the mouth of Prince Creek, half way down Chipp River, about the head of Meade River, at the head of the Itivluk, and down the Aniuk River to the Noatak, although scarce in the vicinity of the latter. An Eskimo who had crossed the mountains to the head of Anaktuvuk River in 1920 found "plenty of caribou." Information from the Arctic slope eastward is not so detailed, but no doubt the herds range near the mountains all the way to the Canadian border and beyond.

In early times caribou were found along the Arctic coast of Alaska, and various accounts indicate that they were plentiful at times.

Bailey and Hendee (1926, p. 22) while at Wainwright in 1921 learned from an Eskimo that in the old days "the caribou were so abundant that the Eskimo seldom went back into the hills to hunt, but waited at the fords of the rivers and killed the animals with bows as they crossed." Various other accounts of prospectors and natives indicate a former abundance along the Arctic coast. In later years they largely disappeared in this area, owing no doubt partly to the activities of whalers, fur traders, and natives. The introduction of reindeer herds would of course eliminate the wild caribou in occupied areas, but very probably the decrease in numbers of caribou had taken place before the reindeer became a factor. Merely a change of feeding grounds, a seeking for new range that had been left untouched for a long period, may have been a contributing factor.

Thomas Riggs, Jr., former Governor of Alaska (1920), estimated that there were 60,000 caribou in the herds he observed at the international boundary in northern Alaska. Including the herds over this whole northern region, in the Porcupine and Peel River country, along the Brooks Range, and in outlying districts, this estimate is probably conservative.

SUMMER AND WINTER RANGES

Information is lacking as to whether there is any definite territory that might be called the summer range of the northern herds, and it seems probable that the animals are more or less scattered in many parts of their general range, seeking local areas suitable for summer feeding. Reliable observers have informed the writer that caribou may be found in the Peel River country during summer, in some places mainly does and fawns; and in the Old Crow River Basin an occasional caribou was found in the summer of 1926.

In winter the caribou occupy the territory along the Porcupine, all the way from Old Rampart House, on the Alaska side, to La Pierre House in Yukon Territory, and according to some reports, all the way to the head of the Porcupine. Throughout this area, of course, they are not evenly distributed, but will be found in separate localities where winter food conditions are favorable.

MIGRATIONS

The distribution and migration of caribou in the Porcupine region confirms observation in other localities that although there is a migration, it may be complicated by minor and countermovements. Furthermore, when the trek is over, it is difficult to say clearly just where the herd has gone, for the reason that animals are still scattered here and there over much of the entire range. In fact, much of the territory occupied by the northern herd is so far removed from ordinary travel that it has been extremely difficult to gather sufficient information with which to work out the entire migration route, and data are available for only a rough outline.

Considering first the Koyukuk-Chandalar region, there is a general southwestward movement from the region of the East Fork of the Chandalar, following the divide between the Koyukuk and Chan-

dalar waters, continuing until the headwaters of the Hodzana, Dall, and Kanuti are reached. This movement occurs in fall, but it is difficult to assign definite dates. Several successive migration waves appear to take place. Early in October many caribou have already reached the southern end of the range, yet later, perhaps late in October or early in November, other bands are observed traveling southward from Bettles River, on the upper Koyukuk. Bettles River seems to be a favorite resort, and many caribou enter the Koyukuk Valley by way of that river course. In recent years bands of caribou, in their travel from the eastern headwaters of the Chandalar to the upper Hodzana country, have been veering farther southward—taking a short cut, in other words—and crossing the Chandalar Valley below Caro. The stray records near Beaver on the Yukon, Fort Yukon, and similar stations are an expression of this same tendency toward a more southerly route.

For comparison it is interesting to note that in the early days, when the miners stampeded into the upper Koyukuk, game was so scarce that cattle were shipped up the Yukon and driven overland from Beaver to Wiseman to supply meat for the camps. Later, caribou were brought to this camp all the way from the East Fork of the Chandalar, which became a favorite hunting ground. Gradually the herds moved south and west, until game could be obtained from the upper South Fork of the Koyukuk, hunters working out from Coldfoot. In recent years the caribou have been working still farther along and since 1920 have been coming into the Middle Fork Valley of the Koyukuk. In the early winter of 1924–25 they were plentiful in the immediate vicinity of Wiseman, and moved past Bettles and even Allakaket, where several Indians said they had never seen them before. They also appeared in considerable numbers on the Melozitna Flats still farther south, and even as far as Tanana. Possibly this tendency will once more populate the Alatna River district with these game animals; areas of suitable lichens occur in that locality, and an Eskimo told the writer that at one time caribou were there. Eskimos from the Arctic slope in those days used to come over the Endicott Mountains at the head of the Alatna to hunt mountain sheep and caribou and to obtain supplies of birch wood.

Apparently there are two migration routes, and possibly there is a split in the herd near the Canadian border. According to Thomas Riggs, Jr., the herds at the head of Old Crow River split, one part going westward along the north slope of the Endicott Mountains and the other taking a more southern route. The latter represent the animals that cross the upper Coleen and Sheenjok Rivers and enter the Chandalar watershed, principally by way of the East Fork (p. 64).

The northern section, traveling on the Arctic face of the range, also moves westward, but it is probable that there is an influx from this group over the range and into the upper Koyukuk Valley. In the early winter of 1924–25 no tracks were found on the Koyukuk itself much above Bettles River, and it is safe to say that such a crossing over the range would occur to the eastward. Several Eskimos of the upper Koyukuk expressed the belief that the cari-

bou came from "the Arctic." This might explain the late annual migration "wave" that in recent years has taken place on the Koyukuk, after the range to the south has already become partly occupied by a somewhat earlier migration.

Some Eskimo information has still further bearing on this movement. Several Kobuk Eskimos, living on the Alatna, said that "in the old days", when caribou were plentiful on the Arctic side, they traveled east and west, parallel with the mountain range, going through a "narrow place between the mountains and the ocean", in the east, in which they referred without doubt to the region of Firth River, where the Brooks Range approaches the Arctic coast.

A trader on the Yukon, who had lived at Point Barrow, said that caribou traveled westward by that point and returned eastward by a more inland route, nearer the mountains.

Information from various sources indicates that in a general way the migration north of the mountains took place in a westerly direction in autumn and easterly in spring, but as the caribou migrations are irregular and complex, in this case they may have been complicated by a tendency to visit the coast region in summer and the mountain slopes in winter, a north-and-south movement.

This more or less extensive migration on the Arctic slope clearly does not now exist. On the other hand there seems to be a southward shifting of the migration lines, with an increase in numbers south of the mountains, an enrichment of the southern area at the expense of the northern.

The summer and winter ranges are hard to differentiate (p. 66). There is an influx to the Koyukuk-Chandalar divide for winter, but it is not clear where the animals spend the summer. A certain number, as in other herds, may be found on the "winter range" in summer, and many return northward and eastward for summer, but this migration, if such it may be called, is indefinite and unnoticeable.

The route of migration of that part of the herd on the Canadian side, may be traced eastward by Rampart House, along the Old Crow Mountains, and southward by the high lands bordering the Porcupine River into the upper Peel River country and Nahoni Lakes. There is no question that this is the route of travel, but opinion differs as to its direction at certain seasons. During the first week in August 1926, the caribou appeared in the Old Crow Mountains, northeast of Rampart House, and the numbers were augmented by later arrivals. The natives from Old Crow Village obtained more than 400 animals during the fall hunt. According to a former member of the Royal Canadian mounted police at Rampart House, caribou in fall cross the Porcupine southward at that point and return northward in spring. An Indian at that station said the same thing.

At Old Crow Village, to the eastward, the chief of the Indians informed the writer that the caribou appeared in that vicinity in fall, having come from the "Chandalar", and traveled to the head of the Porcupine. This would also be in a southerly direction. He stated that the animals returned northward in spring, and further that an influx of caribou generally occurred in August from the north, but these soon returned northward and reappeared in October on their southward trek. According to this Indian, the "Yukon" caribou

(by which he meant animals from far south) come north in fall and mingle with the northern group.⁸

Other reports also appear to point to a southerly migration in fall. In August 1926 caribou appeared at Old Crow Mountain, as the Indian had predicted, and apparently from the north. They probably followed the mountains surrounding Old Crow River Basin, for few had been seen in the basin itself at this time.

It may be said, then, that there is a local migration in August, and that the main run occurs in October along the route indicated. It is clear that there is free communication among the caribou, a connected distribution, all the way from the headwaters of the Porcupine and Peel Rivers in Yukon to the Brooks Range in Alaska, including the Chandalar animals.

YUKON-TANANA HERDS

OCCURRENCE

By far the largest number of caribou west of the Mackenzie River occupy mainly the uplands between the Yukon and Tanana Rivers and the contiguous areas in Yukon Territory. Farther eastward in Yukon, caribou have been observed in various places, but whether these animals form a definite part of the Yukon-Tanana group is uncertain. One who had traveled extensively in the eastern part of Yukon informed the writer that he had found caribou along the mountain range extending from the head of McNeil River in Yukon Territory southward as far as the head of Jennings and Cottonwood Rivers in northern British Columbia. He believed that their distribution was confined within a strip averaging 50 miles in width. Though unacquainted with conditions north of McNeil River, this observer had noted caribou on "Level Mountain" east of Tuya Lake, in an area north of the middle reaches of Jennings River, and on a mountain north of Blue River—all in northern British Columbia—and in Yukon on a mountain situated midway between the foot of Atlin Lake and a mountain southwest of McClintock Peak. Caribou were also said to occur down the Liard River to a point about 300 miles below Liard Post, but no farther. According to Indian information, caribou reach the summit of the Coast Range near Skagway but do not occur on the south slope. This eastern territory was not visited during this investigation, and the distribution of caribou therefore was not worked out in detail. These notes, however, indicate rather definite points of contact between the caribou of the Yukon-Tanana herd and those of British Columbia.

Indeed, much confusion has existed concerning the boundaries of the range of the Yukon-Tanana caribou and the limits of the animals' movements, and certain points are still obscure, many details remaining to be worked out. The range of these animals is, however, so closely associated with their migrations that one can hardly be discussed without the other, and as the fall migration is the most striking feature, and the most definite in character, it will be discussed at this point.

⁸ It is sometimes difficult to decide how to use such Indian information. The Indians' observation is likely to be most accurate, especially in the case of caribou, on which they depend for food and for whose coming they watch so carefully. Their judgment as to what takes place at a distance, however, may be faulty.

FALL MIGRATION

The main divide between the Yukon and Tanana Rivers may be considered the principal highway of travel for these caribou in Alaska, though they do not always adhere to it closely. At the headwaters of the Chena River, northeast of Fairbanks, a northwestward movement is noticeable, generally late in July. One season the caribou were first noted there on July 28, which appears to be the average date for that locality. In the fall of 1920, while stationed on Boulder Creek, a tributary of upper Chena River, the writer watched the caribou moving in a general northwesterly direction until September 11. On that date a few were seen traveling in the opposite direction. On the next day individuals were seen going in both directions, but on the following day the migration was definitely southeastward. The White Mountain region had been the temporary goal of the animals' summer travel, and they had not crossed the Yukon at Rampart in any numbers. On the return journey, southeastward, the animals had become concentrated and appeared in large bands in many sections.

The principal area covered by this migration extends from the White Mountains district and the vicinity of Rampart on the Yukon in a southeasterly direction, covering the upper tributaries of both the Tanana and Yukon, into Yukon Territory as far as Whitehorse. In some seasons the caribou swing down to the Chatanika and Chena Rivers, so as to pass close to Fairbanks; in other seasons they keep more to the main divide, farther east. Occasionally a few animals cross the Tanana River southeast of Fairbanks, traveling more and more southward until at the Delta River a considerable number may cross the lowlands of Tanana Valley into the Alaska Range. Others cross the valley near the mouth of Healy River and other points up the Tanana, over to the slopes of the Alaska Range. Having arrived at this mountain chain, a great many move eastward along its north slopes in a direction parallel with the range, but others cross the mountains by way of the Delta River, by Mentasta Pass, or by less-traveled routes over the range. One winter these caribou ranged south of the mountains to the vicinity of Copper Center. Many of them reach the headwaters of the Tanana, Nabesna, Chisana, and White Rivers.

On the Yukon River side of the divide the herds sometimes pass within 8 or 10 miles of Circle, but they ordinarily confine themselves to higher ground, as far back as Miller Creek, and do not often enter the low swampy area in the angle of the Yukon that includes Beaver and Birch Creeks. However, at Woodchopper Creek, the Nation River, and at Eagle the animals reach the banks of the Yukon itself and even cross the river in some numbers. Various crossings of the Yukon are well known, the chief of which are in the vicinity of Woodchopper Creek and Nation River. Others are near Eagle and Fortymile, as well as at points above Dawson. The main migration passes within a few miles of Eagle, the American Summit being a favorite crossing, and goes thence on into Yukon Territory, across the Sixtymile River, parallel with the Yukon River and principally on the south side. A goodly number may finally arrive in the vicinity of Whitehorse, as they did in the fall of 1924. According to several old timers, the caribou

run had not previously extended as far as Carmack and Whitehorse since these men came into the country—periods varying from 20 to 33 years. Certain Indians declared that caribou used to be at Haines, Alaska, and they thought that the animals were working back that way. In early times Fortymile was an important crossing. Sometimes several thousand caribou cross in these places, but these in reality constitute only a small part of the main herd. They are sufficiently numerous, however, to reach and mingle to some extent with the Peel River herd, which ranges about the heads of Peel and Porcupine Rivers and their many tributaries. There thus appears to be a rather definite intercommunication between the two herds by way of the Nation River and the Klondike River districts.

Above Dawson many local crossings, where caribou habitually swim the Yukon, are known to the prospectors and others inhabiting that region, who reported that caribou cross the Yukon in fall at many points from some distance below Fort Selkirk to Indian River. Other crossings occur just below the mouth of White River, at the mouth of Stewart River, at Rosebud Creek, ABC Creek (below Fort Selkirk), Coffee Creek, and Selwyn. Some of these localities are little known except to local prospectors or other woodsmen who have opportunities to note these small features of the great migration of caribou.

According to information received from local residents, it is apparent that the highlands between Sixtymile River and White River and between the Klondike and Stewart Rivers are highways of travel for caribou.

WINTER RANGE

The large herd having made its long journey, one might wonder where the animals assemble and where they spend the winter. As a matter of fact, all do not assemble on any one winter range, but small groups are scattered along the whole route of travel from the White Mountains to Whitehorse, irregularly distributed, some localities harboring only a few small bands, others none, and still others numbers so large that the animals are considered "plentiful."

In all sections certain areas are favorite resorts, the supply of lichens and condition of snow being important factors. It was reported that many caribou had wintered in the hills near the mouth of White River, in the Kluane Lake region, and elsewhere southeast of Dawson. Small bands wintered south of the Yukon near Selwyn and on Nisling River. Apparently the snow lies too deep on most of the south slope of the Coast Range to furnish caribou an area for winter use. It is known that caribou winter to some extent on Ladue Creek, along the upper White River, in the Chisana River region, and in some seasons abundantly in the basin of the upper Fortymile River. Sometimes the animals do not remain in the Fortymile basin for winter, and at such times local Indians and prospectors are unable to get caribou meat except during the fall migration. Limited numbers spend the winter on upper Goodpaster River and in other parts of the Yukon-Tanana highland. The writer has found caribou on the upper waters of the Chatanika River in February, this being a locality not far from the northwestern end of their range.

Mention has been made (p. 70) of an occasional migration over the Alaska Range, by way of Delta River and Mentasta Pass. It is definitely known that the caribou appeared at the head of Delta River three winters—1918-19, 1919-20, and 1920-21. In the fall of 1920 these caribou appeared at Paxson Roadhouse in the middle of October, reached McCallum's telegraph station in December, and continued northward nearly to the mouth of Phelan Creek, which seemed to be their limit. They had come from the north slope, through Mentasta Pass, part of the herd going northward on Phelan Creek and others going in a southerly direction to Poplar Grove, where they remained until March, after which they moved to the vicinity of Mount Drum. An observer at Mentasta Pass had estimated that 10,000 or 12,000 animals had gone over the pass that fall. Some had reached the vicinity of Copper Center. In April the caribou had returned toward Mentasta and were gone from the south slope in May.

SPRING MIGRATION AND SUMMER RANGE

In the spring of 1921 the writer witnessed the return of the caribou to the north side of the Alaska Range at Tanana Crossing. The first animals were seen on April 28, coming over the summit of the range, down the north slope, and then swinging off parallel with the range for some distance, on the lower slopes. Having reached the lower slopes, they moved slowly, stopping and bunching up on favorable knolls to feed and sometimes gathering in a herd numbering as many as 500. Some of the herds did not move more than 2 miles a day. On this first day about 4,000 passed. The next day only about 1,500 moved by, and on the following day few were coming over the mountains. Altogether about 6,500 crossed from the south side, probably following the course of Tok River, and dispersed in the Tanana Valley, all making for the general region of the upper Fortymile or Goodpaster Rivers. These animals were nearly all does, most of them heavy with fawn.

Earlier that season, on April 11, a fur trader had seen caribou crossing the Tanana 10 miles above Tetling, in an easterly direction, traveling over a path 3 miles wide. Another trader, stationed at Tetling Lake during this migration, stated that about the last of April or the first of May, thousands of caribou passed that place in a northerly direction. He estimated that 5,000 or more crossed in one day and believed that more caribou passed at Tetling Lake than at Tanana Crossing.

All of these caribou were leaving their winter range and heading for the fawning grounds and the summer ranges in the Yukon-Tanana divide. This movement represents only a small part of the general shifting of the caribou over a wide stretch of territory. Little is known about the spring migration in general. A movement of caribou herds has been observed in a number of localities in spring, but since the herds are not concentrated at this time and do not travel so far nor so steadily as in the fall, it is difficult to determine just where they go. Numerous localities that cannot be named serve as spring and summer range. It is certain that many caribou remain on the higher parts of the Yukon-Tanana divide during the spring months, and many have been observed in summer on the upper Yukon,

particularly on Swede Dome, near Dawson, in the vicinity of the mouth of White River; near Fort Selkirk; and in the Coast Range south and west of Whitehorse. Some spend the spring and summer on the upper White River. In July caribou were observed along the upper Fortymile River, and a herd estimated to number 30,000 came into Mosquito Flats in June. On July 5 and 6, a prospector watched a herd of at least 15,000 animals, probably many more, at the head of Healy River, near the head of the Middle Fork of Fortymile River.

At various times during spring and summer, herds may be observed traveling here and there, until near the end of July they may be seen in a more definite journey northeastward by the heads of Goodpaster, Chena, and neighboring rivers, and in September the regular return migration begins.

TAXONOMIC STATUS OF ALASKA-YUKON CARIBOU

While this investigation has not been concerned directly with caribou taxonomy, the study of distribution and migratory routes of the Alaska-Yukon herds is closely related to the distribution of described forms. For this reason the classification of the groups involved is here considered. A completely satisfactory understanding of the situation can be had only by a revision of the genus, which is badly needed but well-nigh impossible with material now available in the collections. The synopsis here given is confined to the caribou of the Alaska-Yukon area.

All specimens available from the North American continent have been studied, as well as some from the Old World, in all, 283 skulls and 122 skins. Fortunately, from some localities there are large series, particularly in the Biological Survey collection. Special attention was given during these investigations to collecting a comparable series from interior Alaska. The extensive collection of the United States National Museum was studied, and important material examined in the collections of the American Museum of Natural History, New York. A few specimens also were examined in the collection of the Academy of Natural Sciences of Philadelphia, a number at the Field Museum of Natural History, Chicago, and some in the Colorado Museum of Natural History, at Denver.

Unfortunately, however, much of the museum material is not comparable. Skins taken late in winter or in spring are practically useless for taxonomic work, and skins in good, unfaded condition, as well as skulls, must be segregated by sex and age. The result is that even in a large collection, any one comparable series becomes disappointingly small. Even among specimens considered fully adult there is some uncertainty, for it is not always known at what age growth ceased. Furthermore, there is a lamentable lack of material of any kind from certain critical localities.

The study of museum specimens was complemented by field observations on color, size, form of antlers, and other characters. Thousands of caribou were observed in the field, and many sketches and measurements of horns were made (figs. 4 to 13). Finally, valuable light is thrown on the problem in some cases by the facts of distribution and migration.

The following forms have been described from Alaska and Yukon Territory:

- Rangifer stonei* Allen, from Kenai Peninsula, Alaska.
R. granti Allen, from the western end of Alaska Peninsula, opposite Popof Island.
R. arcticus ogilvyensis (Millais), from Ogilvie Mountains, north of Dawson, Yukon Territory.
R. excelsifrons Hollister, from Meade River, near Point Barrow, Alaska.
R. mcguirci Figgins, from Kletson Creek, a tributary of the White River, Yukon Territory, 4 miles east of the Alaska-Yukon boundary.
R. osborni Allen, from Cassiar Mountains, British Columbia. (This form enters Yukon Territory.)

The present investigation indicates that the Alaska-Yukon caribou differ among themselves only subspecifically and that they comprise three subspecies of *Rangifer arcticus*—*R. a. stonei*, *R. a. granti*, and *R. a. osborni*. The taxonomy then is as follows:⁹

Order ARTIODACTYLA—Even-toed Ungulates

Family Cervidae—Deer

GENUS RANGIFER Hamilton Smith—CARIBOU AND REINDEER

RANGIFER ARCTICUS (Richardson)—BARREN-GROUND CARIBOU

[Pertinent synonymy under subspecies]

The first taxonomic question under consideration is the relationship of the New World group with those of the Old World. A number of Old World specimens have been examined, but as the series available is fragmentary and scattered as to locality, it does not warrant any conclusions. In the absence of evidence to the contrary and in conformity to usage, it is assumed that the Nearctic are distinct from the Palearctic forms.

Study of available material of *Rangifer caribou* and *R. arcticus* is most confusing. There is, of course, the matter of size and weight. It is generally believed that the "woodland" caribou is, on the whole, a much heavier animal than the typical *arcticus* from the barren grounds of northern Canada. Here again, however, precise information is limited. Records of animal weights in literature are often subject to question. Rarely does the author state the age of the animal for which a weight is given, and it is not always clear that the animal really was weighed.

⁹ No attempt at revision is here made, but for the sake of completeness and of suggesting possible relationships, the subspecies of *Rangifer arcticus* heretofore described (with the exception of *R. a. ogilvyensis*, a synonym of *R. a. stonei*, for which see p. 76) are quoted from Gerrit S. Miller (1924, p. 491) as follows:

- Rangifer arcticus arcticus* (Richardson). (Barren-ground Caribou.)
 1829. *Cervus tarandus* var. *arctica* Richardson, Fauna Boreali-Americana, v. 1, p. 241.
 1885. *Rangifer tarandus* and *R. tarandus groenlandicus* True, U. S. Natl. Mus. Proc. (1884) 7:592. 1885.
 1896. *Rangifer arcticus* Allen, Amer. Mus. Nat. Hist. Bull. 8:234. November 21, 1896.
 TYPE LOCALITY.—Fort Enterprise, Mackenzie, Canada. (See Allen, Amer. Mus. Nat. Hist. Bull. 24:584, September 11, 1908.)
Rangifer arcticus caboti G. M. Allen.
 1914. *Rangifer arcticus caboti* G. M. Allen, New England Zool. Club Proc. 4:104. March 24, 1914.
 1915. *Tarandus rangifer labradorensis* Millais, The Gun at Home and Abroad, v. 4, p. 259 ("... horns brought into Nain, Davis Inlet, and Fort Chimo").
 TYPE LOCALITY.—Thirty miles north of Nachvak, eastern Labrador, Canada.

The woodland form is considered darker. This may be a sound conclusion, but there is so much individual variation in color among caribou that even this character should be questioned, and perhaps the judgment holds true only on the average.

Antler form appears to be a fairly reliable distinction if used with discretion. Unquestionably, the average antlers of *R. caribou* are flat and fairly heavy, rather short in beam, as compared with the more rangy antlers of typical *R. arcticus*.

Skulls of the two groups were compared in a vain effort to find a really stable, diagnostic character. Certain skulls appeared to indicate that *arcticus* was characterized by a more prominent, protruded orbit. While this may be a satisfactory distinction between certain forms, it cannot be applied to the two larger groups without numerous exceptions. One can without difficulty pick out 1 or more skulls of 2 described forms and find satisfactory, sometimes striking, differences but in a sufficient number of specimens to form a comparable series such distinctions are minimized, if not altogether nullified, by many skulls that do not fit into the scheme.

With an inadequate series of typical *arcticus*, and also of typical *caribou*, hard and fast conclusions are impossible. Specimens from the Yukon-Tanana herds show many points of resemblance to those of typical *arcticus*. Alaskan antlers are long and rangy, thus approaching *arcticus* rather than *caribou*. Though the Mackenzie River Valley apparently has acted as a barrier between the great herds of northern Canada, representing *R. arcticus*, and the groups found in Yukon and Alaska, such barriers also appear to exist on a small scale within Alaska. As mentioned before (p. 67), in the winter of 1924 a great migration swept over the lower Alatna and Koyukuk Rivers and caribou crossed the Yukon River near the mouth of the Tanana in considerable numbers. Similarly, in recent years there has been a slight encroachment on the Yukon Flats, several animals having been killed not far from Fort Yukon, to the great surprise of the Indians. On the Alatna River, caribou had been absent as long as the adult Indians could remember.

This is typical caribou behavior, and could easily be true on a larger scale. With their long migrations, the routes of which are changed after longer or shorter periods, it seems unlikely that communication has been cut off between the herds east and west of the Mackenzie for a period long enough to produce two distinct species.

As a matter of fact, characters appear to overlap. The basal length of 35 Alaskan specimens varies from 344 to 403 mm, with an average of 369 mm. The same measurement from only 4 barren-ground caribou from northern Canada varies from 361 to 367 mm, average 365 mm. Of 8 specimens from northern Canada the maxillary tooth row varied in length from 84 to 98 mm, average 88.9 mm, as compared with an average of 94 mm among 44 central Alaskan specimens, ranging from 85 to 107 mm. Thus we find all measurements overlapping in their range of variations, and the same is true of skull proportions and shape. As previously noted (p. 74), records of weight or size of caribou in literature are rarely specific in details, but it would appear that the Alaskan caribou are heavier than typical *Rangifer arcticus*.

Because of the overlapping of characters and the proximity of the ranges of the two groups, even though the boundaries do not definitely meet at present, and because *R. arcticus* is the first form described for continental North America, the Alaskan animals are here considered as subspecifically related to *R. arcticus*.

RANGIFER ARCTICUS STONEI Allen

STONE'S CARIBOU

Rangifer stonei Allen, Amer. Mus. Nat. Hist. Bull. 14: 143-148, May 28, 1901.

Rangifer excelsifrons Hollister, Smithsn. Misc. Collect. 56 (35): 5, February 7, 1912. Type locality, Meade River, near Point Barrow, Alaska.

Rangifer mcguirei Figgins, Colo. Mus. Nat. Hist. Proc. 3 (1): 1, December 28, 1919. Type locality, Kletson Creek, a tributary of White River, Yukon, Canada.

Tarandus rangifer ogilvyensis Millais, The Gun at Home and Abroad, v. 4, p. 263, 1915. Type locality, Ogilvie Mountains, north of Dawson, Yukon, Canada.

Type locality.—Kenai Peninsula, Alaska.

Type specimen.—No. 16701, American Museum of Natural History, ♂ adult, head (skin and skull), collected September 24, 1900, by Andrew J. Stone.

Geographic range.—Most of central and northern Alaska, excluding Alaska Peninsula and Unimak Island; also in western Yukon, Canada, more sparingly to the eastward; the form is absent from most of the southern coastal belt of Alaska, having been exterminated on Kenai Peninsula and is scarce in western and parts of northern Alaska.

Diagnostic characters.—A large caribou, probably approaching the greatest in weight, dark in coloration, with well-developed white fringe on throat. Antlers large and rangy, of the *arcticus* type, but heavier.

Remarks.—Stone's caribou was the first form described from the Alaska-Yukon area. Although the type locality is the Kenai Peninsula, various authors have assigned the animals of interior Alaska to this form, and the writer's studies have resulted in conclusions in harmony with this practice. There are now very few specimens from Kenai in existence, and the caribou have disappeared from that peninsula. In all important characteristics, however, the type specimen can be duplicated almost indefinitely among the interior-Alaska caribou, which have been here designated the Yukon-Tanana and the Alaska Range herds (p. 57). The Kenai material would fit into any large series of the latter without exhibiting greater differences than occur among specimens from any one locality. As a matter of fact, the characters of *R. stonei* as given by J. A. Allen (1901) are typical of the animals from interior Alaska. This is especially true of the antlers, and to one who has observed the Yukon-Tanana animals in great numbers and has studied the antlers particularly, those of the type specimen have a familiar appearance. Allen gives the length of beam as 1,170 mm. Of 58 fairly comparable specimens from the interior, the average length of beam was 1,125 mm, with a maximum of 1,510 and a minimum of 777 mm. At least 24 specimens exceeded the measurements of Allen's type specimen, and several others were only slightly smaller. Thus the antlers of the type are fairly close to the average of those found in interior Alaska. This applies equally well to the structure and general appearance.

It is difficult to determine the significance of any given skull measurement of caribou, in view of the individual variations. Of 35 specimens, the basal length varied from 344 to 403 mm, with an average of 369 mm plus.

The length of tooth row appears to be a fairly reliable character. Of 44 specimens from the interior, the average length of maxillary tooth row is 94 mm, with the minimum 85 and the maximum 107 mm. Allen gives 95 mm for the type specimen. The color of the pelage, as shown by the head and neck of the type and the mounted specimen of an adult male in the Field Museum of Natural History, Chicago, appears typical of the pelage found among the interior herds.

It may be argued that the Kenai Peninsula, which includes the former range of the caribou from which the type specimen was taken, is isolated from other caribou ranges. In a certain sense this is true. Some of the areas lying between Kenai Peninsula and the Alaska Range are not typical caribou country. In other parts of Alaska, however, caribou have frequently crossed extensive unsuitable range to reach another that is favorable. The timbered Tanana Valley is not strictly caribou country, yet in recent years caribou have been crossing it regularly. Moreover, records show that these animals probably inhabited country not far from Kenai Peninsula. J. Alden Loring (1902, p. 145) mentions a caribou head at Tyonek which had been brought from the Susitna River district, and he learned that caribou were common in the country some 75 miles north of Tyonek. Indians from the Matanuska River district frequently brought caribou skins to the trader at Knik. Osgood (1901, p. 62), discussing the caribou of Kenai Peninsula, states: "They are more or less common a short distance in the interior and are often killed near the Susitna River, whence their skins are brought to the coast to be traded."

No reason is apparent for assuming that a barrier for caribou exists on the mainland near Kenai Peninsula. During the time of the writer's investigations in Alaska, a number of exceptional migrations took place, as when the caribou invaded the Melozitna country from the north and when animals ventured as far as Whitehorse and even to the summit of the coast range above Skagway—not to mention those that entered the Yukon Flats and those that crossed the Tanana Valley. Mathys (P. G. Lowe, 1899) reports that a caribou was killed on the divide at the head of Chickaloon River on August 12, 1898, and it has been shown (p. 70) that caribou from the north sometimes come south over the Alaska Range into the upper Copper River region. The Kenai Peninsula seems to be simply an overflow area that probably often received an influx of caribou from unusual migratory movements of interior herds. If it were not for the interference of men, Kenai Peninsula would no doubt once more in due time become inhabited by caribou.

As a result of these considerations and the fact that no difference whatever is noted between available Kenai material and the abundant specimens from interior Alaska, these animals are, therefore, considered without doubt to be of the same form.

Synonyms.—It is difficult, with only a comparatively small series of specimens, to say that a distinct form of caribou does not occur near Point Barrow, but on the other hand there is not sufficient valid evidence available to support the recognition of a distinct form.

Rangifer excelsifrons was described by Hollister in 1912 on the basis of a single skull. He had several others, female and immature, but these were not comparable. The chief distinguishing character of the type specimen is the high, abruptly rising forehead, which if

present also in a series of specimens would indeed establish a valid form. On the basis of cranial characters alone, however, one cannot escape the conclusion that *excelsifrons* rests on an unusual skull. After this form was described, Alfred M. Bailey obtained a number of topotypes, some of which are deposited in the Biological Survey collection. Most of these, unfortunately, had part of the frontal bone removed with the antlers, thus destroying the critical cranial character, but none of the more perfect skulls exhibits a forehead so sharply rising as in the type. Furthermore, the type appears to be decidedly smaller than any of the comparable topotypes. The topotypes agree very well in general appearance with *R. a stonei*, both in size and general proportions, making due allowance for individual variation. The length of beam of two sets of antlers is 1,260 mm and 1,356 mm, which fall into the general range of measurements for *stonei*.

In the Colorado Museum of Natural History, Denver, are two mounted caribou groups—one from interior Alaska and one from the region back of Wainwright—that apparently show a difference in pelage. Those from the Wainwright district appear decidedly lighter in color, with variations among the five individuals of the group. The interior Alaska group appears uniformly darker.

There are several considerations involved here, however. A large series of skins from interior Alaska does not show such uniformity of color as is exhibited by this mounted group, a great variation having been found in markings and in shade of coloring. The northern group in the Colorado museum shows a variable amount of white on the crown and forehead. Both extremes, from pure white to plain brown, with all intermediate mixtures, are to be found among the more southern herds, even in specimens from British Columbia, and it can be stated positively that the white markings about the head are entirely unreliable as characters. Witmer Stone's description (1901) of a series collected by McIlhenny in 1897-98 indicates rather pale coloration also. After thus noting the general variability of coloring in all groups, one finds it difficult to rely on this character.

Joseph Dixon, who has visited both the Arctic slope and interior Alaska, has written (letter of May 5, 1930):

... In my experience, there is considerable individual variation regarding the lightness of color in young caribou, and the light-colored individuals are just as likely to be found in the McKinley region as along the Arctic coast between Point Barrow and Mackenzie.

In the same vein R. M. Anderson writes (Aug. 28, 1930):

In northern Alaska I did not notice that caribou calves in fall or early winter pelage were paler in color than caribou of the same age from other parts of the Arctic. It is a very difficult matter to compare the colors of caribou, as they vary during almost every month of the year. . . . I collected two young fawns near the Colville Delta, Alaska, 16 June 1909, which were quite different in color, one being decidedly brown, with short, sleek coat; the other was whitish gray and softer, more woolly in texture. They were of about the same size, but one may have been born a few days before the other.

Anderson thinks also that the caribou of northern Alaska may possibly be a little darker on the average than those east of the Mackenzie.

The remarks of Dixon and Anderson agree with the writer's observations in the field as well as with his examination of specimens.

Granted that some of the few available skins appear paler, the same is true of skins from other parts of Alaska, and it is difficult to judge how much weight should be given to this variable character. There is also the consideration that domestic reindeer have been mingling with wild caribou to some extent for years. On this question Bailey and Hendee write (1926, p. 22):

Large numbers of reindeer are constantly escaping the herders and joining the wild caribou. It seems that it will be but a short time until there will be no pure-bred caribou along that part of the coast. Fifteen hundred deer were missing from the herds at Wainwright and Icy Cape at one time during our stay, and stray deer are sometimes killed by the caribou hunters among the wild animals. As the reindeer are protected, and the caribou are killed at every opportunity, the former will doubtless prove the dominant animal and in time overcome the caribou, with hybridization the inevitable result.

Known hybrid caribou observed in interior Alaska showed little uniformity. Some bore indications of the reindeer strain in color and carriage, particularly the shorter legs, but others did not reveal the reindeer inheritance. Since reindeer have been straying along the Arctic coast for years, and the caribou have been comparatively scarce in the same districts for a considerable time, perhaps hybridization has already taken place to a large extent, and it is certain that a hybrid is difficult to identify among the wild animals.

Furthermore, it would seem almost certain that when the caribou of the Arctic slope were abundant, there must have been practically continuous distribution from the Meade River district on the west to the Canadian boundary on the east. Eskimo traditions and the records that can be found bear out this suggestion. Considering the extensive migrations of these animals, it is safe to conclude that the caribou found in the Endicott Range are the same form as those from Meade River. Furthermore, an available series of specimens from the Endicotts could not be satisfactorily distinguished from *stonei* of interior Alaska.

In view of these considerations, the meagerness of data, the distribution of the herds as shown by their migrations, and particularly the fact that the original description does not apply, one would not be justified in substituting other doubtful characters, based on a few specimens, to uphold *excelsifrons* as a valid form.

Rangifer mcguirei was described by Figgins from Kletson Creek, a tributary of the White River, Yukon Territory. No part of the original description would distinguish the type specimen from *R. arcticus stonei*. Furthermore, the type locality lies squarely in the path of migration of the large herd of *stonei*, the principal herd of Alaska-Yukon caribou, at a point where hundreds of thousands pass through each year during the rutting season. This fact alone would eliminate the possibility of there being a local form in the vicinity of White River. The Kenai caribou are identical with those of interior Alaska, and consequently *mcguirei* must be eliminated as a valid form.

Tarandus rangifer ogilvyensis was used by Millais for the caribou of the Ogilvie Range. These were referred by Osgood (1909, p. 49) to *arcticus*, as part of the so-called "Peel River" herd. Reference to the map (fig. 16) shows that this herd is rather closely identified with the great herd of *stonei* of the Yukon-Tanana region. Each year a part of the latter herd crosses the Yukon between Nation River and

Eagle, and others work northerly in the vicinity of Dawson, thus reaching the Ogilvie Range. Furthermore, the Peel River caribou migrate great distances along the Porcupine River, and there is a continuous distribution from the Ogilvie Mountains north, then west, into the Chandalar and Koyukuk River Basins, the animals there again coming in contact with the Yukon-Tanana herds at the western end of their range.

In this study it has been impossible to differentiate the series of specimens of the Koyukuk-Chandalar-Porcupine area from *R. a. stonei*. Two specimens from upper Coal Creek, Yukon, fit into the large series from central Alaska, exhibiting no greater differences than several specimens from central Alaska would show. Osgood states (1909, p. 50) that "the skulls and teeth are practically identical with those of typical *arcticus*", and as already mentioned (p. 75), satisfactory cranial characters that in a large series would definitely distinguish typical *arcticus* from the Alaskan caribou cannot be found.

Referring to Millais' original description of *ogilvyensis*, one finds nothing that would distinguish the Ogilvie animals from *stonei*. Millais states that "the position of *T. r. ogilvyensis* is therefore exactly similar to that of *O. m. fannini* amongst the mountain sheep and if one holds good the other must be accepted." This statement, however, does not take into consideration the habits of the animals in question, and it would be difficult to find two game species more incomparable in this respect. Mountain sheep are fairly stationary and cling pretty closely to certain ranges. Caribou, on the other hand, are among the most migratory of mammals. Considering the migrations in question, the constant mingling of animals from two large herds year after year, and the enormous distances traversed, it is not considered proper to assign a local race to the Ogilvie Mountain area.

RANGIFER ARCTICUS GRANTI Allen

GRANT'S CARIBOU

Rangifer granti Allen, Amer. Mus. Nat. Hist. Bull. 16: 119-127, March 31, 1902.

Type locality.—Alaska Peninsula, western end opposite Popof Island, Alaska.

Type specimen.—No. 17593, American Museum of Natural History, ♂ adult, collected October 29, 1901, by Andrew J. Stone Expedition.

Geographic range.—Alaska Peninsula and Unimak Island, formerly Unga and other islands at the west end of Alaska Peninsula and probably northward some distance along the Bering Seacoast.

Diagnostic characters.—Averaging somewhat smaller and paler than *R. a. stonei*, many antlers diverging widely and with sharply recurring beams, although these antler characters may not hold uniformly in a large series.

Remarks.—The caribou of the Alaska Peninsula, in their present depleted numbers, are isolated from the interior herds. At one time, however, there was no doubt a certain degree of communication between the two groups (p. 59). Nelson wrote the author:

In the years not far antedating my arrival at St. Michael, in 1877, caribou occurred practically all along the coast of Bering Sea of Alaska from Norton Sound to the peninsula except in limited areas, such as the delta of the Yukon and some of the marsh areas between Yukon and Kuskokwim. . . . I am convinced that the caribou of the peninsula were in contact with those farther north but may have been sufficiently isolated to form a local race.

Comparison of available material from Alaska Peninsula and study of data on early distribution corroborate this conclusion: The peninsula herds have been sufficiently isolated to form a local race, but the differences are not striking.

Study of specimens would indicate that *granti* averages somewhat smaller than *stonei*. The basal lengths of only two adult skulls of *granti* are available—341 mm and 323 mm, as compared with an average of 369 mm in central Alaska—and two specimens are insufficient for definite conclusions. Of six comparable specimens, the average length of maxillary tooth row is 94.5 mm, about the same as for *stonei*. J. A. Allen (1902a), however, found much larger measurements in the series he studied.

Examining a series of antlers from Alaska Peninsula and Unimak Island indicated that there is a tendency toward wide divergence of the beams, which also averaged lighter in weight than those of *stonei* and in a number of instances showed a tendency to recurve sharply forward. The same wide spread is indicated somewhat in Allen's figure (Allen, 1902a, p. 121). Not all antlers from this area exhibit this type of growth, and a wide divergence is frequently found in central Alaska, but the available specimens apparently show a definite tendency in this direction.

After allowing for the great color variation among caribou, it still appears that *granti* averages paler—not only in adults, but also and more strikingly in the younger animals. J. A. Allen (1902a) describes a 6-month animal as "creamy white", generally resembling the "summer coat of the white sheep (*Ovis dalli*)." Another is described as somewhat darker. A mounted group in the American Museum of Natural History appears rather pale in coloration, but mounted specimens are subject to fading. Several skins in the Biological Survey collection, from Unimak Island, average paler than many skins from central Alaska, but none approaches the "white" skin described by Allen. A skin in the American Museum, no. 36592, from Pavlof Bay, is decidedly darker than others examined.

One must constantly keep in mind the great variability, both in color and dimensions, among caribou, and as a consequence distinguishing characters are rather vague and unsatisfactory. Judging by the specimens examined, however, the antlers of *granti* appear to have a tendency toward wide divergence, are comparatively slender and light, usually without a great number of points; the pelage may average a little paler; and the animals in general probably are smaller than *stonei*. The small size is generally conceded by writers, and among the comparatively few specimens examined during this study nothing has been found to the contrary. On the basis of these average characters, therefore, the name *Rangifer arcticus granti* is considered applicable to these animals.

RANGIFER ARCTICUS OSBORNII Allen

OSBORN'S CARIBOU

Rangifer osborni Allen, Amer. Mus. Nat. Hist. Bull. 16: 149-158, April 16, 1902.

Type locality.—Cassiar Mountains (60 miles southeast of Dease Lake), British Columbia.

Type specimen.—No. 15714, American Museum of Natural History, ♂ adult, collected September 1897, by Andrew J. Stone.

Geographic range.—Northern British Columbia and parts of southern Yukon, Canada.

Diagnostic characters.—Much like *stonei* but averaging somewhat darker, with the dusky tipping of the white throat fringe more pronounced; tooth row longer.

Remarks.—The center of abundance of *R. a. osborni* may be designated as northern British Columbia, while the Yukon-Tanana herd of the Alaska-Yukon area represents *stonei*. In comparing series of specimens from the two regions the difference between these forms becomes surprisingly small. As expressed by Osgood (1909, p. 17), "moreover, the differences between the two are all relative, excessively variable, and rather intangible."

In color of pelage there is perhaps less difference than one might suppose. Indeed, at first the writer was inclined to believe that there was none. There does, however, appear to be an average darker shade in *osborni*, a slight tendency toward the dark *montanus* farther south. In many specimens there is a light brownish or smoky tint at the tip of the long white beard, which appears to be a little more prevalent among specimens from British Columbia than among those from Alaska. But the general aspect and the markings, or uniform, of the two groups are essentially the same.

No strongly marked, consistent differences in antlers were found except for a resemblance to the woodland type in certain British Columbia specimens (p. 83). Antlers of *stonei* are probably fully as large, if not larger on the average, than those of *osborni*, with similar variations and general characters. Of nine specimens measured from British Columbia, the average length of beam is 912 mm, with the maximum 1,300 mm, while similar measurements of 58 *stonei* gave an average of 1,125 mm, with the maximum 1,510 mm.

No satisfactory weight records were found for a series of *osborni*, but animals from northern British Columbia are considered large and heavy and may possibly average heavier than *stonei*. Further data are needed on this point.

A distinct difference is noted in the length of tooth row, the most tangible character found. Of 21 skulls from northern British Columbia the average length of maxillary tooth row is 100.5 mm—maximum 106 and minimum 83 mm. The mandibular tooth row of 22 specimens averaged 106.8 mm—maximum 113 and minimum 95 mm. On the other hand, of 44 specimens of *stonei* the maxillary tooth row averaged 94 mm, with the maximum 107 and the minimum 85 mm.

Thus, while *osborni* and *stonei* can be differentiated, they undoubtedly intergrade, judged not only by measurements but by distribution and migrations. Logically, therefore, the name *Rangifer arcticus osborni* would more correctly indicate the taxonomic position of the northern British Columbia group. One adult male from Plateau Mount, MacMillan River, three from Riddell River, Yukon Territory, and one from Wolf River average 103 mm in length of maxillary tooth row—maximum 107 and minimum 100 mm—measurements decidedly greater than the average of *stonei*. These specimens are referable to *osborni*. It was definitely determined that *R. a. stonei*, the great Yukon-Tanana group, at times migrates south-eastward in great numbers to the vicinity of Whitehorse, thus approaching very closely the known range of *osborni*. The scattered

caribou found near the Yukon-British Columbia boundary, about Wolf River, the headwaters of Pelly and MacMillan Rivers, are outside the migratory route of *stonei*, and the measurements given above indicate that these are referable to *osborni*. The contact between *R. a. stonei* and *R. a. osborni* may thus be indicated roughly.

CARIBOU OF BRITISH COLUMBIA AND ALBERTA

In determining the status of *Rangifer a. osborni* it is advisable also to consider briefly the possible relationships of all the western caribou, though the habitats of some are remote from the area under consideration. All accounts indicate that the caribou of British Columbia and western Alberta are much less migratory than are the northern animals, in this respect resembling the woodland form. *R. a. osborni* occupies the more northerly parts of British Columbia. While *R. montanus* was described from the Selkirks by Seton and *R. fortidens* from Smoky Mountain region by Hollister, the mountain caribou of Seton appears to be distinguishable readily enough from *osborni*. Eastward, in Alberta, are animals much like typical woodland caribou. They have the rather short, flat horns common to this group. Whether these are generally referable to *fortidens* is difficult to say without study of a series of specimens and detailed consideration of distribution. It is interesting to note that in northern British Columbia it appears that the flat "woodland" type of antler is not uncommon in the range of *osborni*. Indeed, such antlers are found even in central Alaska, in the range of *R. a. stonei*. Furthermore, *osborni* is characterized by large cheek teeth, in common with specimens from Alberta, and it seems logical to consider *osborni* as an intermediate form between the stocky antlered woodland caribou to the southeast and the more "rangy antlered" representatives of the barren-ground caribou to the north, with closer affinity to the latter. If sufficient numbers of specimens could be assembled a study of the series might easily show a closer relationship between the woodland and barren-ground groups than is sometimes suspected, and the transition would be found in the so-called "mountain caribou" group.

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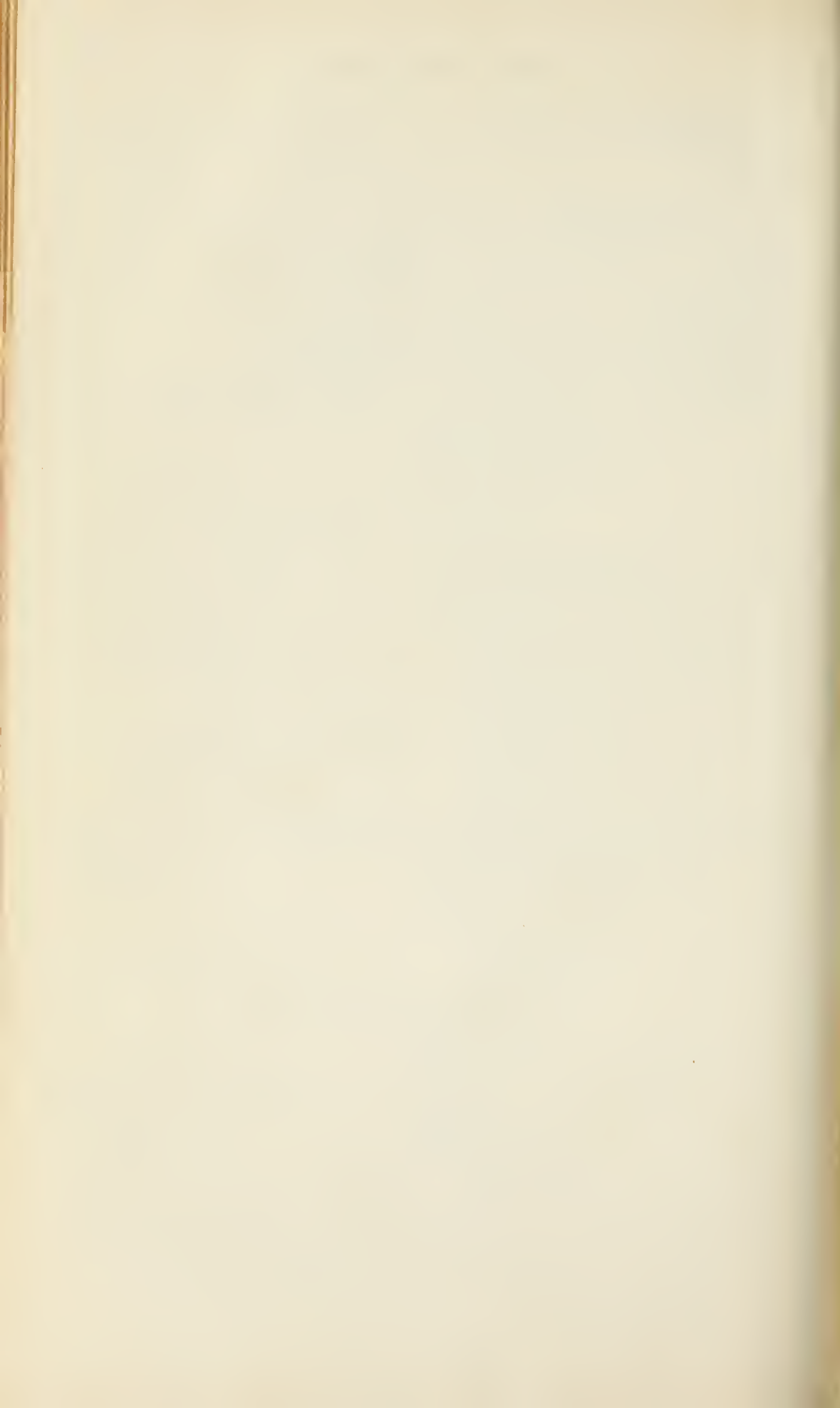
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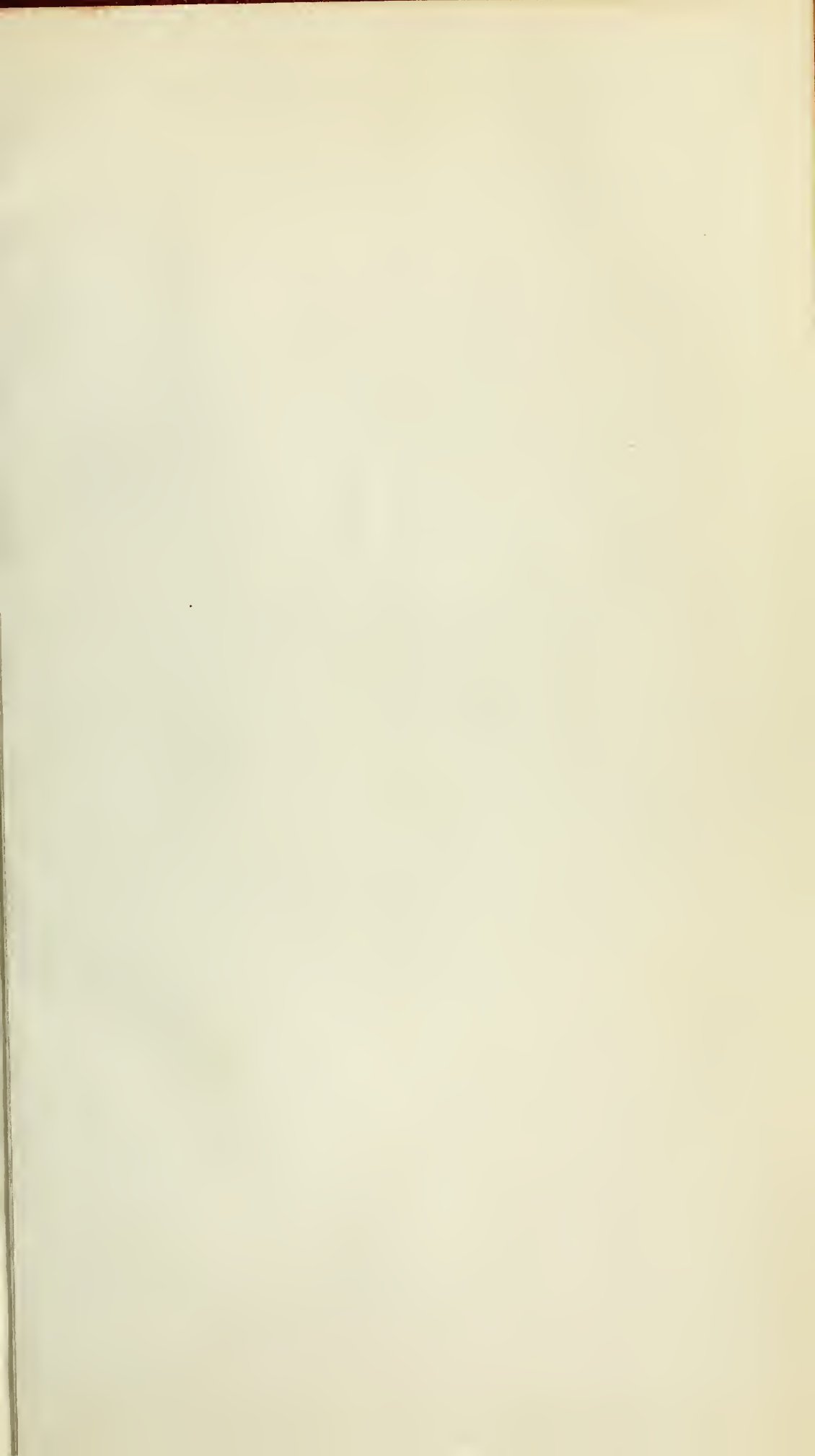
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*No. 41. Review of the Grizzly and Big Brown Bears of North America (Genus *Ursus*), with Description of a New Genus, *Vetularetos*. By C. HART MERRIAM.
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*No. 42. Life Zone Investigations in Wyoming. By MERRITT CARY.
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*No. 43. The Rice Rats of North America (Genus *Oryzomys*). By EDWARD A. GOLDMAN.
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*No. 44. Revision of the American Flying Squirrels. By ARTHUR H. HOWELL.
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No. 45. A Biological Survey of Alabama: I, Physiography and Life Zones. II, The Mammals. By ARTHUR H. HOWELL.

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No. 47. Revision of the American Pikas (Genus *Ochotona*). By ARTHUR H. HOWELL.

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No. 48. Voles of the Genus *Phenacomys*: I, Revision of the Genus *Phenacomys*. II, Life History of the Red Tree Mouse (*Phenacomys longicaudus*). By A. BRAZIER HOWELL.

Pp. 64, pls. 7, figs. 11 (incl. 5 maps). 1926. Price 20 cents.

No. 49. A Biological Survey of North Dakota: I, Physiography and Life Zones. II, The Mammals. By VERNON BAILEY.

Pp. 226, pls. 21 (incl. 1 colored map), figs. 8 (maps). 1926. Price 60 cents.

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No. 51. A Taxonomic Review of the American Long-tailed Shrews (Genera *Sorex* and *Microsorex*). By HARTLEY H. T. JACKSON.

Pp. 238, pls. 13, figs. 24 (incl. 19 maps). 1928. Price 50 cents.

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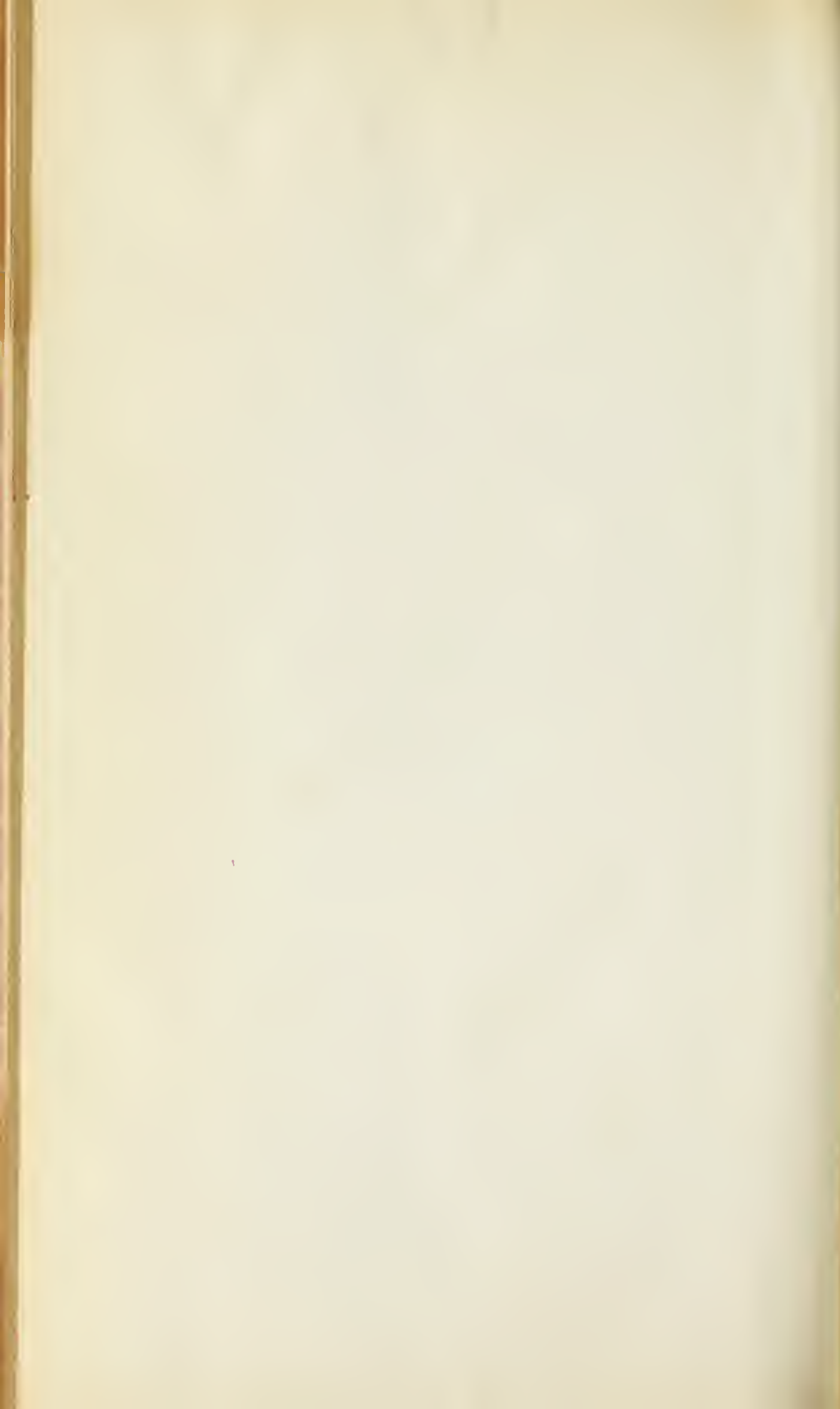
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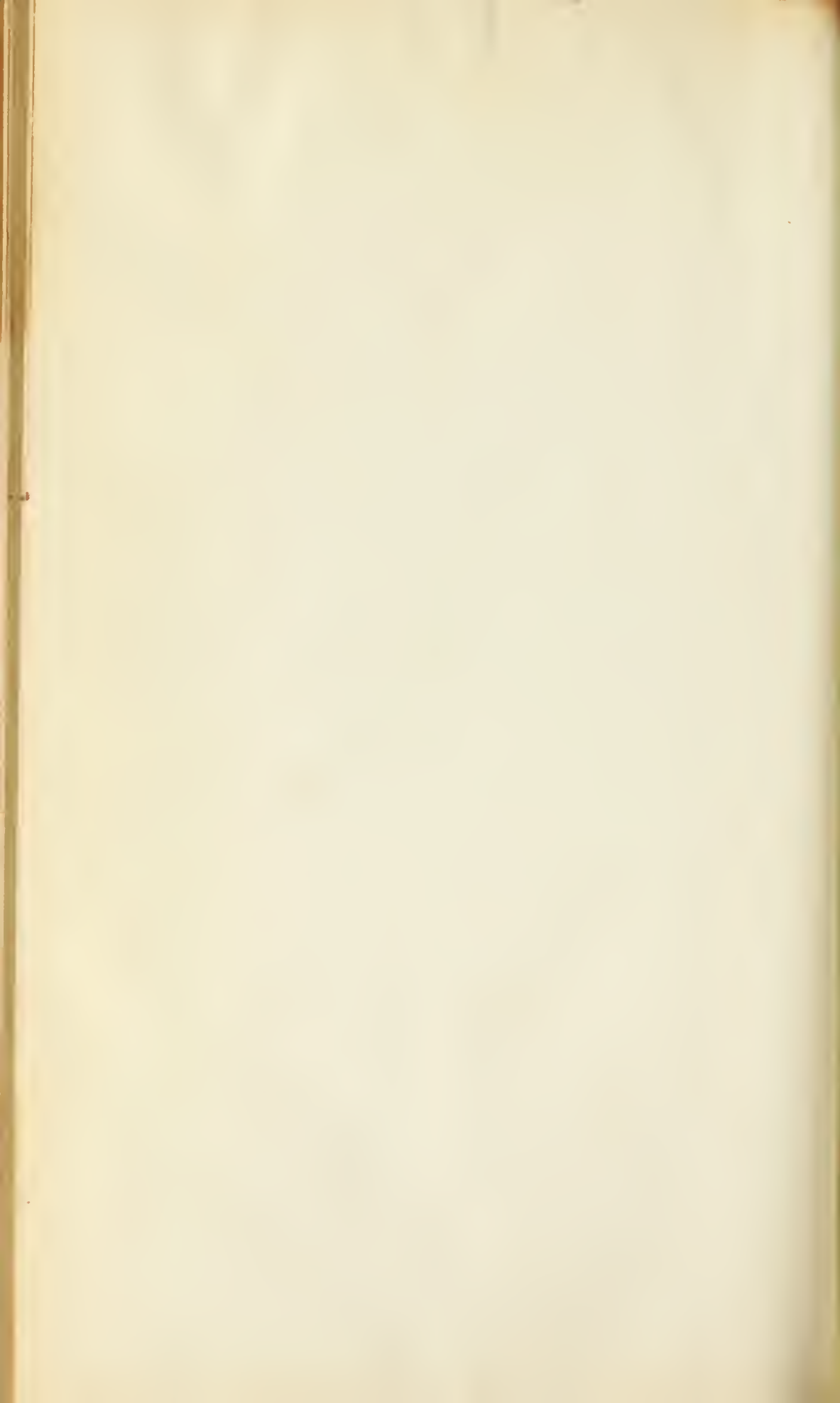
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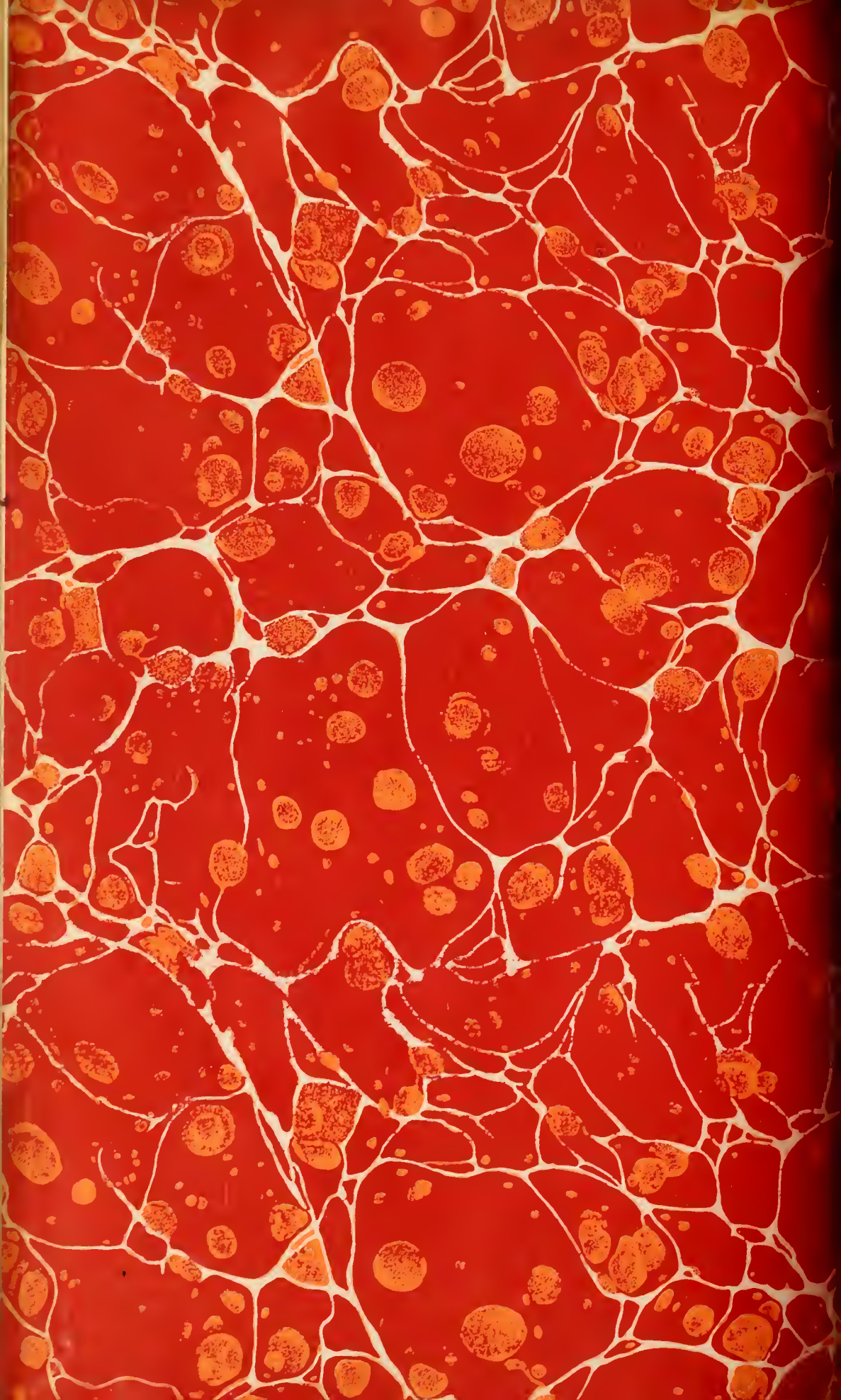












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